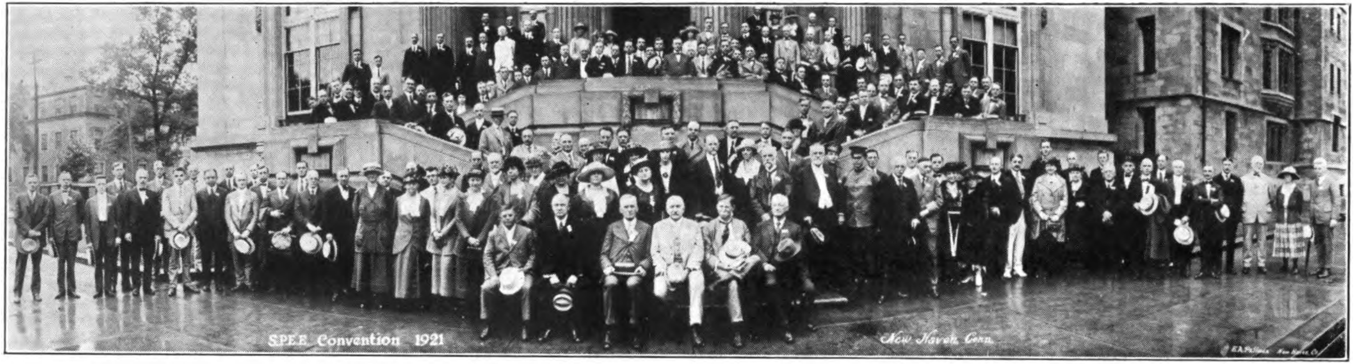

MEMBERS AND GUESTS AT YALE MEETING.

Society

FOR THE

Promotion of Engineering Education

PROCEEDINGS

OF THE

Twenty-Ninth Annual Meeting

HELD AT

YALE UNIVERSITY
NEW HAVEN, CONN.
JUNE 28–JULY 1, 1921

VOLUME XXIX

PUBLICATION COMMITTEE

MORTIMER E. COOLEY, ARTHUR F. GREENE, JR., F. L. BISHOP

F. L. BISHOP, EDITOR

PITTSBURGH, PA.
OFFICE OF THE SECRETARY
1922

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FINAL PROGRAM FOR THE 29th ANNUAL MEETING, YALE UNIVERSITY, JUNE 28–JULY 1, 1921.

TUESDAY, JUNE 28.

(Daylight Saving Time.)

11:30 A. M. Meeting of the Council, Graduates' Club.
12:30 P. M. Luncheon for the members of the Council, Graduates' Club.
2:00 P. M. Opening Session, Sprague Memorial Hall.
Address of Welcome, Russell H. Chittenden, Director Sheffield Scientific School, Yale University.
2:20 P. M. Response, Mortimer E. Cooley, President of the Society.
2:25 P. M. Alumni Engineering Associations, Francis G. Pratt, Vice President General Electric Co., and President Yale Engineering Association.
2:40 P. M. College Education as Related to Industry, J. E. Otterson, President Winchester Repeating Arms Company.
2:55 P. M. Report of the Treasurer.
3:00 P. M. Report of the Secretary.
3:05 P. M. Report of Committee No. 22—Intelligence Tests, L. L. Thurstone, Chairman.
3:40 P. M. Report of Committee No. 14—Business Training, Morris Knowles, Chairman.
3:50 P. M. Report of Committee on Engineering Experiment Stations, Chas. S. Howe, Chairman.
3:55 P. M. Appointment of Committees on Resolutions and Nominations.
4:00 P. M. Seeing Yale. Trips about the University with guides.
5:30 P. M. Organ Recital, H. B. Jepson, University Organist, Woolsey Hall.
8:00 P. M. Getting acquainted, Memorial Quadrangle and Headquarters.

WEDNESDAY, JUNE 29.

9:00 A. M. Meeting of the Council, Byers Hall.
9:30 A. M. *Second Session: Topic, The Curriculum.* Mason Laboratory of Mechanical Engineering.
Address: Arthur Twining Hadley, President, Yale University.

9:45 A. M. Engineering at Yale—Recent Developments, John C. Tracy, Chairman of the Division of Engineering, Sheffield Scientific School.

9:55 A. M. Discussion.

10:10 A. M. General Studies in the Engineering Curriculum, W. H. Burr, Emeritus Professor of Civil Engineering, Columbia University.

10:25 A. M. Discussion.

10:40 A. M. The Problems of Training an Engineer in the Public Service, W. A. Bassett, Staff Engineer, New York Bureau of Municipal Research.

10:55 A. M. Discussion.

11:10 A. M. Engineering Teaching and Practice, W. F. M. Goss, President Railway Car Manufacturers.

11:25 A. M. Discussion.

11:40 A. M. Report of Committee No. 8—Admission, O. J. Ferguson, Chairman.

12:30 P. M. Luncheon, Lawn Club.

Third Session—Topic, The Student. New Haven Lawn Club.

2:00 P. M. Mental Discipline versus Culture in College, Geo. F. Swain, Professor of Civil Engineering, Harvard Engineering School.

2:15 P. M. Discussion.

2:30 P. M. Student Government, P. H. Daggett, Professor of Electrical Engineering, University of North Carolina.

2:45 P. M. Discussion.

3:00 P. M. Some Results of the Coöperative System, J. W. Hallock, Director of Coöperative Work, University of Pittsburgh.

3:15 P. M. Discussion.

3:30 P. M. Report of Committee No. 10—Mathematics, L. C. Plant, Chairman.

3:45 P. M. Report of National Committee on Mathematical Requirements, J. W. Young, Chairman.

4:00 P. M. Discussion.

4:15 P. M. Auto ride to nearby points of interest.

6:30 P. M. Shore Dinner, followed by " Get Together " Meeting.

THURSDAY, JUNE 30.

8:30 A. M. Meeting of Institutional Delegates, Byers Hall.
Report of Committee No. 7—Institutional, T. U. Taylor, Chairman.

Fourth Session. Topic, The Faculty. Dunham Laboratory of Electrical Engineering.

9:30 A. M. Symposium on Training of Engineering Teachers—
(*a*) What is being done to improve the personnel of engineering teachers?
(*b*) What is being done to train teachers for their work?

10:30 A. M. Thoughts on Engineering Education, Rudolph Hering, Consulting Engineer, New York City.

10:45 A. M. Report of Committee No. 9—Administration, H. S. Evans, Chairman.

10:50 A. M. Report of Committee No. 17—Electrical Engineering, C. F. Harding, Chairman.

11:05 A. M. Report of Committee No. 19—Drawing, R. S. Kirby, Chairman.

11:15 A. M. Report of Committee No. 20—Standardization of Technical Nomenclature, J. T. Faig, Chairman.

11:25 A. M. Report of Committee on Resolutions.

11:30 A. M. Report of Committee on Nominations.
Election of Officers.

12:00 M. Cars to Country Club.

1:00 P. M. Buffet Luncheon, Country Club.

2:30 P. M. Round Table Discussion, L. P. Breckenridge, Professor of Mechanical Engineering, Sheffield Scientific School, presiding.
Foundation Mathematics, Physics and Chemistry for Engineering Students, Geo. B. Pegram, Dean, School of Engineering, Columbia University.
The Problem Method of Teaching.
SPEE Plans for the Coming Year.
Engineering Extension.
Coöperation with Commercial Associations, such as N. E. L. A.

7:00 P. M. Annual Dinner (Dress strictly informal), Country Club.
Address by Mortimer E. Cooley, President of the Society.
Address by Calvert Townley, Vice President The Federated American Engineering Societies.
Address by Hon. Edwin Denby, Secretary of the Navy.

FRIDAY, JULY 1.

9:30 A. M. Boat Excursion, Long Island Sound.

LOCAL COMMITTEE.

John C. Tracy, *Chairman*,

L. P. Breckenridge,
G. P. Day,
S. W. Dudley,
F. B. Johnson,
C. H. Mathewson,
M. A. Osborn,
C. F. Scott,
C. J. Tilden.

Reception and Registration.

C. F. Scott, *Chairman,*

C. T. Bishop,
H. V. Bozell,
C. S. Farnham,
E. O. Waters,
G. F. Wittig.

Rooms and Meals.

F. B. Johnson.

Entertainments and Excursions.

L. P. Breckenridge, *Chairman,*

C. H. Mathewson,
M. A. Osborn,
I. T. Hook,
H. L. Seward,
G. A. Stetson,
R. H. Suttie,
H. M. Turner.

Entertainment for Ladies.

Mrs. J. C. Tracy, *Chairman,*

Mrs. L. P. Breckenridge,
Mrs. S. W. Dudley,
Mrs. C. H. Mathewson,
Mrs. C. F. Scott,
Mrs. C. J. Tilden.

Program.

S. W. Dudley, *Chairman,*

S. E. Barney,
R. S. Kirby,
P. G. Laurson,
E. H. Lockwood,
L. W. W. Morrow,
Arthur Phillips,
W. J. Wohlenberg.

Address all mail to
Committee for the S. P. E. E. Convention,
Room 120, Winchester Hall,
New Haven, Connecticut.

MINUTES OF THE TWENTY-NINTH ANNUAL MEETING

YALE UNIVERSITY, NEW HAVEN, CONN.

JUNE 28–JULY 1, 1921.

The twenty-ninth annual meeting of the Society for the Promotion of Engineering Education was held at Yale University, New Haven, Conn., June 28 to July 1, 1921. The sessions were held in the Sprague Memorial Hall, Mason Laboratory of Mechanical Engineering, Dunham Laboratory of Electrical Engineering, New Haven Lawn Club, and the New Haven Country Club. There were 319 in attendance.

MINUTES OF THE REGULAR SESSIONS.

TUESDAY, JUNE 28.

Opening Session.

The meeting was called to order at 2:00 P.M. by the President, Mortimer E. Cooley, Professor of Mechanical Engineering and Dean of the College of Engineering, University of Michigan, who introduced R. H. Chittenden, Director of Sheffield Scientific School of Yale University. Director Chittenden welcomed the Society to Yale. President Cooley responded for the Society.

Mr. F. C. Pratt, President of the Yale Engineering Association and Vice-President of the General Electric Company, read a paper on "Alumni Engineering Associations." Mr. J. E. Otterson, President of the Winchester Repeating Arms Company, presented a paper on "College Education as Related to Industry." This was followed by the reports of the Secretary, Committee No. 14, Business Training, and the report of the Committee on Engineering Experiment Stations.

The President announced the following as members of the Committee on Resolutions: G. C. Anthony, J. R. Nelson, and W. S. Rodman. President Cooley read a telegram from the Secretary of the Navy expressing his inability to attend the meeting. A motion was made and carried that we extend an invitation to the officers of the destroyer flotilla to attend this convention as our guests.

WEDNESDAY, JUNE 29.

Second Session.

The meeting was called to order at 9:30 by President Cooley. Arthur Twining Hadley, President of Yale University, delivered an address. This was followed by a paper on "Engineering at Yale" by Professor J. C. Tracy. W. H. Burr presented his paper on "Some Features of Engineering Education." W. A. Bassett read his paper on "Training in Public Administration for the Engineer." President Cooley read a letter from W. F. M. Goss dealing with "Engineering Teaching and Practice." The report of Committee No. 22, Intelligence Tests, and the report of the Treasurer were read.

Third Session.

President Cooley called the meeting to order at 2:00 P.M. and invited Vice President H. S. Evans to preside. In the absence of Professor G. F. Swain, Dean H. J. Hughes read his paper on "Mental Discipline versus Culture in College." This was followed by discussion. A motion made and carried that the Council be requested to very carefully consider during the coming year, the appointment of a committee, or some other possible method, to carry forward the work which the Carnegie Foundation under Dr. Mann so well began.

P. H. Daggett presented a paper on "Student Government and the Honor System," followed by a paper by T. U. Taylor on "Student Government at the University of Texas." John W. Hallock read his paper on "Some Results of the Coöperative System." Discussion. The report of Committee No. 10, Mathematics, was made by J. W. Young, Chairman of the National Committee on Mathematical Requirements. Chairman John Airey read the report of Committee No. 16, Mechanical Engineering. This committee recommended that a committee on production engineering be appointed. Upon motion this recommendation was accepted.

THURSDAY, JUNE 30.

Fourth Session.

The meeting was called to order at 9:30 by President Cooley, who invited Vice-President T. U. Taylor to take the chair. The report of Institutional Commitee No. 7 was read. This committee recommended that the machinery be put in operation through the Secretary's office for a clearing house for engineering instructors.

2. That the institutional delegates approve the action of the Council that a referendum vote of the institutions be taken in regard to increasing the dues from $10 to $25.

3. That the exchange French professor be invited to address the annual meetings and that the American exchange professor report to the annual meetings.

4. That the President and the Secretary send a letter of greeting to the French professor when he arrives.

This meeting was devoted to the subjects "What is being done to improve the personnel of engineering teachers" and "What is being done to train teachers for their work."

Rudolph Hering read a paper on "Thoughts of Engineering Education." The reports of Committee No. 9, Administration; Committee No. 17, Electrical Engineering; Committee No. 19, Drawing, and Committee No. 20, Standardization of Technical Nomenclature, were read. The Nominating Committee reported as follows:

For officers to serve one year:

For President: Charles F. Scott, Yale University.

For Vice-Presidents: H. J. Hughes, Harvard University; E. J. McCaustland, University of Missouri.

For Secretary: F. L. Bishop, University of Pittsburgh.

For Treasurer: W. O. Wiley, New York City.

For members of the Council to serve for three years: P. H. Daggett, University of North Carolina; J. H. Dunlap, State University of Iowa; M. L. Enger, University of Illinois; J. C. L. Fish, Leland Stanford, Jr., University; F. E. Giesecke, University of Texas; Morris Knowles, University of Pittsburgh; O. M. Leland, University of Minnesota.

Upon motion the Secretary cast the unanimous vote of the Society for the above named officers.

Professors Allen, Anthony, and Taylor were appointed a committee to escort the newly elected President to the chair. President Cooley introduced the new President and he accepted the office with a few remarks.

The President read the report of the Committee on Committees. A paper, "Human Relations of Industrial Engineers" by G. C. Frampton, was read by title.

Fifth Session.

The President called this meeting to order at 2:00 and asked Professor L. P. Breckenridge to preside. G. B. Pegram read a paper on "Foundation Mathematics, Physics and Chemistry for Engineering Students." This was followed by a round table discussion.

A motion made and carried that a committee consisting of three members be appointed; this committee to deal with the subject of licensing engineers. It was suggested that this committee correspond with the committee of The Federated American Engineering Societies and study its model bill.

Annual Dinner.

President Cooley read his address "Some Homely Thoughts on Education." Lieutenant Commander Oscar C. Badger spoke on "The Navy,"

and Calvert Townley, Vice-President of The Federated American Engineering Societies, spoke on the work of that society. The Committee on Resolutions reported as follows:

WHEREAS, The Society for the Promotion of Engineering Education, assembled for its twenty-ninth annual meeting at Yale University, desires to express its keen sense of appreciation to all those who have contributed so bountifully to the success and pleasure of the occasion. Therefore, be it

Resolved, That the thanks of the Society be hereby tendered to the Corporation of Yale University for its many courtesies and for the admirable facilities afforded by the Harkness Memorial Quadrangle and the Headquarters at Dwight Hall; to President Hadley for his charming expressions of interest and of sympathy with the ideals of the Society; to the Sheffield Scientific School for the accommodations afforded by the laboratories and Byers Hall; to Director Chittenden for his hearty and inspiring address of welcome; to the Division of Engineering and the Local Committees for their coöperation which made possible the remarkable perfection of detail which has marked each feature of the session and particularly for the unique and complete arrangement of program so masterfully provided; and for the especial entertainment arranged for by the ladies of the Committees; and to Professor Harry B. Jepson for the delightful organ recital; and, be it

Resolved, further, That the thanks of the Society be expressed to the Honorable Edwin Denby, Secretary of the Navy, for having afforded an opportunity to bring about a closer coöperation in the future between the Navy and the instrumentalities concerned with Engineering Education, and particularly for the arrangements which make available to the Society the transportation by destroyer flotilla to the Submarine Base at New London and the submarine maneuvers and inspection; and to Lieut. Commander Oscar C. Badger, Lieut. B. B. Lanier, and Lieut. M. R. Derx, commanding officers of the flotilla, for their kindly hospitality; and, be it

Resolved, finally, That the thanks of the Society be expressed to the New Haven Lawn Club and to the New Haven Country Club for the gracious privileges extended at the Club houses; to the Kiwanis Club of New Haven for the loan of automobiles so generously made; to the Graduates Club for its hospitality; and to the press of the City of New Haven for its cordial reception and courtesy.

President Cooley turned over the gavel to President-Elect Charles F. Scott, who after a few remarks declared the convention adjourned.

MINUTES OF THE COUNCIL MEETINGS HELD JUNE 28 AND JUNE 29, 1921, AT YALE UNIVERSITY.

Meetings of the Council were held on Tuesday, June 28, at the Graduates Club and Wednesday, June 29, at Byers Hall. The members who attended these meetings were: C. F. Allen, G. C. Anthony, Frederick Bass, F. L. Bishop, H. S. Boardman, F. C. Bolton, M. E. Cooley, H. S. Evans, J. H. Felgar, A. M. Greene, Jr., C. F. Harding, C. S. Howe, D. C. Jackson, M. S. Ketchum, F. W. McNair, J. Raleigh Nelson, W. G. Raymond, E. H. Rockwell, W. S. Rodman, A. N. Talbot, T. U. Taylor, W. H. Timbie, J. C. Tracy, F. E. Turneaure, and W. O. Wiley.

The motions acted upon were as follows:

1. The invitation to hold the 1922 meeting at the University of Illinois be accepted. Carried.

2. The report of the Secretary be accepted. Carried.

3. Resolved that it is the sense of the Council that the Bulletin be continued as in the past.

4. A membership committee of five be appointed by the Council. A local membership committee consisting of three members in each institution be appointed; this committee to report to the committee of five. This local membership committee is to represent the Society at their institution. Carried.

5. A referendum vote be taken of the institutional members increasing their dues from \$10 per year to \$25. Carried.

6. The year book to be printed yearly. Carried.

7. The Society is to coöperate with the American Association for the Advancement of Science, Section M, in the forthcoming meeting at Toronto in December, 1921. Carried.

8. Should the Executive Committee so desire, the Society is to hold a meeting in December with the American Society of Mechanical Engineers, if such a meeting can be arranged. Carried.

9. The Society defer joining The Federated American Engineering Societies. Carried.

10. C. R. Mann was elected to serve for three years on the American Council on Education.

11. The following resolution of the National Research Council was adopted:

"*Resolved*, That the Society for the Promotion of Engineering Education endorses the compilation and publication of a volume of critical tables of physical and chemical constants and other data, in accordance with the plan formulated by the National Research Council."

The following applicants were recommended to the Society for election: Bohle, V. R., Dale, R. B., Miller, J. S. Jr., Stansfield, Alfred, Alden, C. R., Macalpine, J. H., McCabe, F. T., Tudsbury, C. W., Varney, E. A., Voss, W. C., The University of Arkansas, The College of the City of New York, The Johns Hopkins University, Swarthmore College, The University of Tennessee, The Tulane University of Louisiana, Union College.

13. The following budget of income and expense for the coming year was reported by the Executive Committee and adopted by Council:

ESTIMATED RECEIPTS.

From current dues, individual	\$ 6,000.00
From current dues, institutional	847.00
From back dues	500.00
From advertising	1,400.00
From sale of publications	300.00
Estimated receipts	\$ 9,047.00

ESTIMATED EXPENSES.

A.	Yale Meeting (1921)	$ 400.00	
B.	Proceedings, Vol. XXIX	1,800.00	
C.	Engineering Education, Vol. XII	2,500.00	
D.	Committee Expenses	150.00	
F.	Secretary's Honorarium	1,000.00	
H.	Clerical Assistance	2,000.00	
I.	Sundry Printing	250.00	
J.	Postage and Expressage	200.00	
K.	Telephone and Telegraph	50.00	
L.	Office Supplies	50.00	
			8,400.00
	Estimated surplus		$ 647.00

Respectfully submitted,

F. L. BISHOP,
Secretary.

REPORT OF THE SECRETARY FOR 1920–21.

The Secretary is sending this report to the Council in advance of the annual meeting and will have copies available for distribution to the members attending the meeting, in order that members of the Council and the Society may be better informed in regard to the work of the Society.

The financial condition of the Society is always a critical question since we operate on a very narrow margin. I believe it is safe to say that no society gives so much for the dues paid by its members as this Society. During the year 1919–20 the dues were $4. The distribution of this among the six general items of the Society is as follows:

Each member pays $1.76 for Bulletin, which cost $2.50 per member.

Each member pays $1.12 for Proceedings, which cost $1.59 per member.

Each member pays $0.28 for meetings, which cost $0.36 per member.

Each member pays $0.12 for committee work, which cost $0.21 per member.

Each member pays $0.36 for accounting work, which cost $0.51 per member.

Each member pays $0.36 for general Society business, which cost $0.47 per member.

Each member paid $4.00. The Society paid $5.64 per member.

It is evident from these figures that the dues would have to be increased by 41 per cent. to cover the actual operating expense of the Society if our income from other sources was not sufficient to cover this amount. In other words, to come out even, the income from advertising, sale of publications, etc., must amount to $1.64 per member. The cost of publication

has increased materially during recent years while the other expenses of the Society have remained practically stationary. The following table shows this:

Date.	PROCEEDINGS.	*Engineering Education*	Salaries
1914–15	......	......	$ 2,630.00
1915–16	$ 1,099.95	$ 2,578.10	2,500.00
1916–17	1,302.44	1,764.77	2,620.00
1917–18	1,483.39	1,641.31	2,800.00
1918–19	1,269.32	1,961.41	2,500.00
1919–20	1,874.30	2,974.27	2,500.00
1920–21	2,397.54*	3,133.86	2,700.00

* This item protested. No reply yet.

The most efficient method of increasing the income of the Society is to increase its membership.

MEMBERSHIP.

The total membership of the Society is 1,500; 83 of which are institutional and 1,417 individual. We began the year 1920–21 with 1,522 members, of which 73 were institutional and 1,449 individual. We have lost through death, resignations and dropped for non-payment of dues, 84 members. The campaign for new members was conducted as follows:

Early in the fall the Secretary asked a member of the Society in each institution to submit a list of the members of his faculty who were not members of the Society. We received 530 names. Invitations to become members of the Society were sent to each name submitted. As a result of this we received 51 new members. Letters were sent to the members of the Yale Engineering Association inviting them to become members of the Society. One application was received. Notices of the meeting and other activities of the Society have also been sent to these men. We sent a letter on May 9 to the deans of the school of engineering in this country which are not institutional members of the Society, pointing out the advantages of such membership and of being officially represented at the twenty-ninth annual meeting at Yale, and inviting them to make application for institutional membership. Nine applications for institutional membership were received. Letters from six others stated that it was the lack of financial assistance from the state that prevented them from joining.

I believe that a properly organized membership committee can help materially in increasing and maintaining the increase in the Society. I recommend that a standing membership committee of ten members be appointed. That as soon as a member of this committee has secured ten new members to the Society, he be retired from active service on the committee and his place be filled by another member. In this way, the membership committee would be continually changing and the growth of the Society at the same time would be continuous and the work would not be a burden to any individual or group of individuals in the Society. I sug-

gest that the first membership committee be selected from the elective members of the Council. Of course, it is understood that the Secretary's office would coöperate very closely with such a committee.

Annual Meeting.

The attendance at the annual meeting at Michigan was the largest in the history of the Society, 238 members and guests registered. This exceeded the attendance at the Boston meeting in 1912, where there were 215 members and guests registered.

The program for the annual meeting this year has been prepared very largely by the local committee. This is an innovation, since heretofore the technical programs have been prepared exclusively by the Program Committee of the Society. There are many arguments which could be advanced for having the program prepared by the local committee and an equal number for having it prepared by the Program Committee. The main argument in having the program largely in the hands of the local committee at the institutions where the Society is meeting is that the program will emphasize to a greater extent the peculiar characteristics of the work offered at that institution. All programs, of course, should be subject to the approval of the Program Committee of the Society.

A striking feature of the annual meeting this year will be the presence of three destroyers of the United States Navy. These were secured through the personal efforts of Dean Cooley, President of the Society.

The Society has received an invitation from President Kinley of the University of Illinois to hold the 1922 meeting at that institution.

The Proceedings.

The Secretary has endeavored every year to have the Proceedings issued early in the scholastic year in order that the papers and discussions of the annual meeting may be available to members of the Society early in the year. This has been found to be practically impossible of accomplishment in the past. Because of the various strikes and interruptions in the printing trade, I believe we were fortunate in being able to issue the volume of Proceedings even in April, 1921. There have been omitted from the Proceedings certain material, such as the Constitution of the Society, etc., which does and should properly appear in the year book. This has reduced the number of pages quite materially with the resulting decrease in cost.

Bulletin of the Society.

Considerable difficulty has been experienced during the past year in the publication of the Bulletin of the Society—*Engineering Education.* In fact the printers were unable to print either the May or June number and it became necessary to combine these two into a single number containing

the annual program and some other material. Through the assistance of our advertisers we are able to issue this combined number with very little cost to the Society. The question of the size of the Bulletin should be considered very carefully by members of the Council, since the cost of printing has increased rapidly. The editor has attempted to keep the Bulletin down to a minimum number of pages.

It seems to the editor that it would be advisable to make the Bulletin a more personal magazine in regard to its members and other activities. In this connection, I recommend that there be a contributing member in each institution selected from among the younger members of the staff and that he contribute each month interesting items pertaining to the institution and members of the engineering teaching staff, in return for which he is to have his dues remitted for the period during which he is serving the Society in this way. There are undoubtedly young men on the teaching staff of the various institutions who can hardly afford to belong to the Society, and this would not only help them but help the Society.

Committee Work.

A folder was issued in November, 1920, containing a list of the officers, a brief discussion of the origin of the Society, advantages of membership, etc., together with a list of the committees and their duties. A number of these committees have done excellent and progressive work. In the reports of these committees we find material which is always of interest and value to every faculty of the engineering schools. I believe that a larger sum of money should be set aside as soon as it can be made available for the work of these committees.

Special Activities of the Society.

This Society is an international society. We have a number of Canadian members, several of whom have signified their intention of attending the Yale meeting. The meeting in 1897 was held in Toronto. The American Association for the Advancement of Science will hold its annual meeting at Toronto during the holidays beginning right after Christmas this year. As an affiliated society of the association, I recommend that we coöperate with Section M, Engineering, in this meeting, thus creating more interest among Canadian institutions and teachers in the work of the Society.

The Society was represented at various functions during the year:

Inauguration of President Coffman, University of Minnesota—F. W. McNair, President, Michigan College of Mines.

National Engineering Conference on Public Information, American Association of Engineers, Chicago—J. F. Hayford, Director, Northwestern University.

Congress of Mechanical Engineers, New York City—

Organization Meeting, The Federated American Engineering Societies—F. L. Bishop, Dean, University of Pittsburgh.

The members can be of very material assistance to the Society by informing advertisers that they use the material, books, etc., which are advertised in *Engineering Education.*

Personal letters were sent with three of the eight notices of dues and mimeographed letters with four; the first bill being sent out without any letter.

Letters were sent to the institutional members of the Society inviting them to send official delegates to the twenty-ninth annual meeting. The national engineering societies were also asked to send delegates.

REPORT OF TREASURER, JUNE 27, 1921.

RECEIPTS.

Cash on hand, June, 1920		$ 1,147.44
Cash received, Individual Current Dues	$ 5,785.75	
Cash received, Individual Back Dues	474.00	
Cash received, Institutional Current Dues	670.00	
Cash received, Institutional Back Dues	50.00	
Cash received, other sources	2,032.72	9,012.47
		$ 10,159.91

DISBURSEMENTS.

Annual Meeting	$ 397.63	
Committee Expense	76.87	
Clerical Assistants	1,475.00	
Sundry Printing	260.17	
Postage, Expressage, etc.	275.55	
Telephone and Telegraph	44.11	
Office Supplies	26.96	
Accounts Payable	5,674.30	
Secretary's Office, on account	500.00	
Treasurer's Office	25.00	
	$ 8,755.59	8,755.59
Balance on hand		$ 1,404.32

ASSETS.

Accounts Receivable.

Individual Current Dues	$ 985.00	
Individual Back Dues	1,910.25	
Institutional Current Dues	121.00	
Institutional Back Dues	60.00	
Members and non-members	515.04	
	$ 3,591.29	
Inventory	3,179.25	
Cash (Mellon National Bank)	1,404.32	
Cash Life Member Fund	474.62	
Cash Dr. Bishop's Office	150.00	$ 8,799.48

LIABILITIES.

Due Dr. Bishop	$ 500.00	
Due New Era Printing Company	1,346.57*	
Due Whitehead & Hoag	37.42	
Members paid in advance	93.00	
A. E. P. Kerr	498.00	$ 2,474.99

* Bill of April 25, 1921, not passed, is not included in this item.

MEMBERS AND GUESTS REGISTERED.

Allen, Frank C.,
Mrs. Allen,
Miss Allen,
Allen, F. G.,
Anderson, Gardner G.,
Mrs. Anthony,
Airey, John,
Badger, O. C. (Lieut. Com.),
Badger, O. C., Mrs.,
Backers, W. J.,
Baldwin, H. G.,
Banks, Chas. W.,
Barnes, F. A.,
Barnes, F. A., Mrs.,
Barnes, Miss,
Barney, S. E.,
Barney, Miss,
Bassett, Wm. A.,
Bass, Frederic,
Beckwith, Alfred A.,
Beggs, Geo. E.,
Beggs, G. E., Mrs.,
Berg, Ernst J.,
Berg, E. J., Mrs.,
Berry, H. C.,
Berry, H. C., Mrs.,
Berry, Master,
Berry, Master,
Berard, S. J.,
Bird, Harold C.,
Bishop, F. L.,
Bishop, C. T.,
Bliss, C. P.,
Booth, C. E.,
Booth, C. E., Mrs.,
Boardman, H. E.,
Boardman, H. S.,
Boardman, H. S., Mrs.,
Bolton, F. C.,
Boylston, H. M.,
Bradley, S. M.,
Breckenridge, L. P.,
Breslaw, J.,
Brinkley, S. R.,
Brooks, J. Ansel,
Buck, Henry R.,
Buck, H. R., Mrs.,
Cannon, Joseph H.,
Carmalt, L. J.,
Carroll, Howard H.,
Carroll, W. R.,
Chase, Charles H.,
Church, E. F., Jr.,
Churchill, E. P.,
Clewell, C. E.,
Clutz, Frank H.,
Cochran, J. M.,
Coler, C. S.,
Cooley, M. E.,
Cooley, M. E., Mrs.,
Cooley, M. P., Miss,
Cooper, F. L.,
Conner, Samuel L.
Crossman, T. E.,
Crouch, Calvin H.,
Crouch, C. H., Mrs.,
Dale, R. Burdette,
Daggett, P. H.,
Daniels, Joseph,
Daniels, J., Mrs.,
Day, Arthur H.,
Denison, Julian F.,
Derx, M. L. (Lieut.),
Dickinson, L. P.,
Dietz, J. W.,
Doggett, L. A.,

Doggett, L. A., Mrs.,
Dooley, C. R.,
Doolittle, F. M.,
Dudley, S. W.,
Dudley, S. W., Mrs.,
Duff, Wilmer A.,
Duff, Ella P., Mrs.,
Duffey, C. F.,
Dunlap, J. H.,
Dyche, Howard E.,
Edwards, W. W.,
Eldred, John Raleigh,
Ell, Carl S.,
Ell, C. S., Mrs.,
Ellis, J. R.,
Ellis, C. A.,
Elwell, C. C.,
Ennis, Wm. D.,
Esty, Wm.,
Evans, H. S.,
Faig, John T.,
Farnham, C. S.,
Felgar, J. H.,
Fish, F. A.,
Fish, J. C. L.,
Fussell, Lewis,
Folwell, A. Prescott,
Forbes, A. H.,
Forsythe, J. H.,
Franklin, Wm. S.,
French, Arthur W.,
Fyler, L. K.,
Gans, R. L.,
Gans, R. L., Mrs.,
Giesecke, F. E.,
Godfrey, Hollis,
Greene, Arthur M., Jr.,
Greene, A. M., Mrs.,
Hall, W. B.,
Hall, W. B., Mrs.,
Hallock, John W.,
Hamilton, Edward D.,
Harbarger, Sada A., Miss,
Harding, Francis C.,
Hart, Walter T.,
Haultain, H. E. T.,
Hatt, W. K.,
Havemeyer, L.,
Hazeltine, L. A.,
Hayden, Frank D.,
Heck, Robert C. H.,
Hendricks, Geo. F.,
Hering, Rudolph,
Higbie, H. H.,
Hitchcock, E. A.,
Hodgkins, H. L.,
Holden, Charles A.,
Holden, C. A., Mrs.,
Hook, I. T.,
Howe, Chas. S.,
Hughes, Hector James,
Humphrey, Carl T.,
Huntington, Ed. V.,
Ingram, E. L.,
Jackson, Dugald C.,
Jackson, D. C., Mrs.,
James, J. H.,
John, Walton C.,
Johnson, A. R.,
Johnston, D. A.,
Kegerreis, Roy,
Kenerson, Wm. H.,
Kenerson, W. H., Mrs.,
Ketchum, Milo S.,
Ketchum, M. S., Mrs.,
Ketchum, Master,
Kimball, Dexter S.,
Kirby, R. S.,
Kirby, R. S., Mrs.,
King, Morland,
Knowlton, A. E.,
Knowlton, A. E., Mrs.,
Knox, A. D.,
Kolyn, M. D.,
Kovarik, A. E.,
Knight, Carl D.,
Knight, C. D., Mrs.,
Lanagan, W. H.,

Lanier, B. B. (Lieut.,)
Laurson, P. G.,
Laurson, P. G., Mrs.,
Leland, O. M.,
Lendall, Harry N.,
Linstedt, Hilda S., Miss,
Lockwood, E. H.,
Lockwood, Miss,
Lundgren, Leonard,
MacDonald, Tho. H.,
Macomber, G. S.,
Macomber, G. S., Mrs.,
Macomber, J. L.,
Macomber, L. D.,
Mathewson, C. H.,
Mathewson, C. H., Mrs.,
Marriott, James C.,
Mehren, E. J.,
McCaustland, E. J.,
McKeon, Frederick T.,
McKergow, Chas. M.,
McKergow, C. M., Mrs.,
McJoynt, Thomas L.,
McKenry, Nell, Miss,
Mitchell, Louis,
McNair, F. W.,
Monahan, C. V.,
Mott, W. E.,
Moyer, J. A.,
Murphy, J. K.,
Murphy, J. K., Mrs.,
Nelson, J. R.,
O'Brien, B. P.,
Osborn, M. A.,
Palsgrove, Grant K.,
Palsgrove, G. K., Mrs.,
Palsgrove, Miss,
Patterson, Andrew H.,
Paull, N. M.,
Peabody, L. E.,
Pearson, R. A.,
Peck, Leon F.,
Pfeif, G. H.,
Phelon, J. O.,
Phelon, J. O., Mrs.,
Plank, Wm. B.,
Phillips, Arthur,
Pratt, Francis C.,
Prentice, Donald B.,
Pinney, J. C.,
Prout, Curtis,
Putnam, T. M.,
Randall, J. A.,
Raymond, Howard M.,
Raymond, William G.,
Raymond, W. G., Mrs.,
Read, W. T.,
Reed, P. L.,
Rice, L. H.,
Rittenhouse, L. H.,
Rockwell, Edward H.,
Rockwell, E. H., Mrs.,
Rodman, Walter Sheldon,
Roe, Joseph W.,
Roseburgh, T. R.,
Roseburgh, T. R., Mrs.,
Rogers, Chas. E.,
Rowe, Ralph S.,
Rowe, Roger M.,
Sarason, S. D.,
Sarason, S. D., Mrs.,
Sarason, Earnest,
Sayre, Mortimer F.,
Sayre, M. F., Mrs.,
Scott, C. F.,
Scott, C. F., Mrs.,
Scott, Bertha, Miss,
Scott, Dorothy, Miss,
Seward, H. L.,
Seward, H. L., Mrs.,
Shaw, H. B.,
Skene, Frederick,
Skelton, R. H.,
Slavin, W. A.,
Smallwood, Julian C.,
Smallwood, J. C., Mrs.,
Smith, P. F.,
Smith, Richard R.,

Smith, W. P.,
Snow, Charles H.,
Spalding, F. P.,
Spengler, Harry T.,
Steward, R. K.,
Steward, R. K., Mrs.,
Stephenson, S. A., Jr.,
Stevens, A. C.,
Stevens, A. C., Mrs.,
Soderberg, Robert B.,
Steinberg, S. S.,
Stetson, G. A.,
Stetson, G. A., Mrs.,
Stockwell, F. C.,
Suttie, R. H.,
Suttie, R. H., Mrs.,
Swinton, R. S.,
Talbot, A. N.,
Tappan, F. G.,
Taylor, T. Y.,
Thompson, Karl O.,
Thornburg, C. L.,
Thompson, J. S.,
Thompson, K. O.,
Tilden, C. J.,
Tilden, C. J., Mrs.,
Tilden, Elinor, Miss,
Tilden, Carol, Miss,
Timbie, W. H.,
Timbie, W. H., Mrs.,
Townley, C.,
Tracy, J. C.,
Tracy, J. C., Mrs.,
Tracy, Miss,
Turnbull, W. F.,
Turnbull, W. F., Mrs.,
Turner, H. M.,
Turneaure, F. E.,
VanDyck, A.,
Votey, J. W.,
Vreeland, H. H., Jr.,
Walker, Elton D.,
Warner, R. G.,
Warner, R. K.,
Warner, R. K., Mrs.,
Waters, E. O.,
White, A. E.,
Wilder, Amos P.,
Wiley, W. O.,
Williams, J. Paul Jr.,
Williston, A. L.,
Williston, A. L., Mrs.,
Willson, F. G.,
Willson, F. G., Mrs.,
Willson, F. N.,
Wilmot, Sydney,
Wilson, A. M.,
Wilson, L. T.,
Wilson, R.,
Witnington, S.,
Wittig, G. F.,
Wittig, G. F., Mrs.,
Wohlenberg, W. J.,
Wohlenberg, W. J., Mrs.,
Woodworth, Philip Bell,
Young, J. W.,
Young, C. R.

ADDRESS OF WELCOME.

BY R. H. CHITTENDEN,

Director of Sheffield Scientific School of Yale University.

It gives me great pleasure to welcome the Society for the Promotion of Engineering Education to New Haven. The University feels it a high privilege to have this convention held within its walls and welcomes you most heartily, deeming it an opportunity which we gladly embrace to show you something of the ways of Yale in Engineering, and to learn something of the ambitions and purposes of our sister institutions in this important field of work.

As I view it, one of the main purposes of this Society is the *improvement* of engineering education. Engineering education is to be promoted, but with a view to its ultimate improvement. We learn by experience and our present-day conception of engineering is the resultant of the gradually acquired experience of the ages. The knowledge and experience of successive generations are back of us and in front of us lies the opportunity to expand and extend this experience with a view to the improvement of methods and with a view to formulating a more concise understanding of what engineering really embraces.

In the earlier years, the work of the engineer was devoted exclusively to design and construction; it was his function to plan and to build. It matters not whether the work was the building of bridges, railroads, or aqueducts; machines, heating plants or power plants; his work was mainly to design and build machines or structures of some kind. To-day his field is a much broader one and he stands in a way as the master of industry. He is, or should be, a man well trained in the scientific method. With his scientific and technical knowledge, reinforced by experience in the applications of

this knowledge he is above all others best fitted to assume the management of industry. His experience and training render him the logical leader in solving the many complicated problems which arise in connection with labor. To him are brought for solution many questions connected with the vital problem of cost and probable return on capital invested. In his hands rests the problem of how best to organize and conduct a given industry with a view to the highest degree of efficiency and the highest degree of economy.

For all these duties, the engineer must have knowledge, not merely a technical knowledge which may render him competent to deal with certain scientific or technical problems, but that broader knowledge which enables a man to arrive at sane and just conclusions. As a recent writer has said "there can be no justice where there is no knowledge." The engineer of to-day should have broad and intimate knowledge of the various aspects of industry; he should be competent to deal not only with the technical problems concerned, but also with the broader and frequently more complicated general problems that are constantly arising in connection with any large industry.

With this conception of what an engineer may be called upon to do I should like to say a few words concerning the education of the engineer. We should all agree, I fancy, that he must be primarily a man of strength and breadth; possessed of the power of observation, reflection, and expression, with a broad outlook. This, however, he cannot acquire by a too narrow technical training. What I have in mind has recently been very clearly expressed by the new President of the Massachusetts Institute of Technology, Dr. Ernest Fox Nichols. "Engineers have surely the same broad, educational rights and responsibilities as other professional and non-professional men, yet, amid the growing complexities and perplexities of technical education there has been, and is, a steady and strong temptation to introduce more detailed technical courses at the expense of other background building studies. This temptation, weighty as are

the arguments for yielding to it, must nevertheless be steadily and firmly resisted. The problem of modern technical education is indeed most intricate and difficult, but other solutions must be earnestly sought for we cannot afford to sacrifice the breadth of a man to create a too narrowly efficient machine."

It is in this direction, I think, we must turn our thoughts, in order to insure the right type of education for the engineer. With the rapid growth of knowledge, especially in science, there is a natural and to a certain degree excusable desire to introduce into the curriculum many of the newer aspects of applied science that bear directly upon engineering problems, but to my mind we should constantly keep before us the absolute necessity of training our students thoroughly in the fundamentals that constitute the foundation upon which all forms of engineering rest, and consequently see to it that in all our courses there is maintained a solid background which should never be weakened by the substitution of the more highly specialized courses that are constantly clamoring for admission.

Mathematics, physics, chemistry, mechanics, English, one or more modern languages, economics, business finance, accounting, cost analysis, and industrial management, may well be looked upon as essentials in any and every engineering course, and I should be inclined to add if possible psychology and history, for we may well maintain that no great field of human experience can be overlooked if we are to turn out broadly educated engineers.

Further, it is not enough to see that these fundamentals are contained in our courses of instruction, but it is also our duty to see that they are taught with a degree of thoroughness that will ensure a broad and comprehensive understanding of their significance and bearing upon the lines of thought and practice with which they are most closely related. There is not much mental training to be derived from brief informational courses, but mental strength and the power of reasoning and deduction are derived more largely from consecutive

and intensive work in these fundamentals of our education. And yet I recall the remark of an eminent engineer who said in my presence: "Your engineering courses contain too much mathematics. Of what value to the engineer is all this work in the calculus and descriptive geometry. There are plenty of handbooks available that contain all the formulæ any engineer is likely to need in his work and why waste so much time in the study of these abstruse subjects that have no practical value." I do not know how widely such a view prevails, but I do know that such a view, laying stress solely upon the practical, is not conducive to the acquisition of that mental training which should constitute a large part of the education of an engineer.

In our present-day civilization the engineer is destined to be called upon more and more for advice and leadership in solving the industrial problems that confront the world and upon which prosperity and progress depend. If he is to meet the responsibilities that are surely to be his he must have a broad and thorough training, adequate to give him both strength and self-reliance. In no other way can he hope to acquire the breadth of vision that a wise and competent leader must possess; in no other way can he hope to acquire command of himself and others in the varied situations that are certain to confront him.

RESPONSE TO ADDRESS OF WELCOME.

BY MORTIMER E. COOLEY,
President of the Society.

Director Chittenden:

The Society for the Promotion of Engineering Education is very happy to be the guest of Yale University. I am sure I voice the feeling of the members in saying that we have all looked forward to the time when we might come to Yale and live with you awhile in an atmosphere so distinctive as to have, like an old vintage wine, a bouquet of its own. Fortunate indeed the man, whether student or teacher, who has the privilege of living in such an atmosphere and partaking of the inspiration which can come only from years of tradition, the result of high ideals and fine scholarship.

The spirit of your address appeals to us, Director Chittenden, as being exceptionally fine. It is uplifting not only to us as teachers of engineering but to teachers in general. You inspire us to greater enthusiasm and we shall profit by your suggestions.

I should say to you that teachers of engineering are not all predisposed to favor the use of the so-called pocketbooks of engineering formulae but rather to train young men so that they themselves shall be able to prepare such pocketbooks for the use of those who have not had the benefit of an education in engineering. That I am sure is the spirit of those present. Indeed that is the spirit which brings them to meetings of this kind.

Speaking as one who comes from west of the Alleghenies I may assure you that teachers of engineering are anxious to do the very things you have pointed out in your words of welcome should be done. We want our students to be more broadly educated. While we recognize the need of an edu-

cation fitting one for the "pick-and-shovel" work necessary to make a living, we want more to train our students for the great problems of life. I for one do not believe that the engineering profession has yet attained to its fullest influence, and look forward to the time when more engineers will be called to positions of the highest responsibility in our government. Under the leadership of the Federated American Engineering Societies, and with such examples as Mr. Hoover, the public must soon recognize the great public service that can be rendered by engineers.

Your words of welcome will insure us a happy and profitable meeting. Your generosity is much appreciated. Again let me say, Director Chittenden, we are very glad to be the guests of Yale University.

INTRODUCTION OF PRESIDENT-ELECT.

PRESIDENT COOLEY: I now come to the moment which every President of a Society looks forward to—of turning over his duties to his successor. But before I relinquish the gavel I want to take this opportunity to express again my appreciation of the honor which you conferred upon me one year ago. I have enjoyed being your President.

You may not realize it, but you are a very remarkable body of men. You devote more time, more energy, and handle your subjects with greater completeness than any similar group I know. You are patient listening to others and facile; a wonderful lot of speakers. I have listened to you for three days now, and no one has lacked words.

This Society is so virile, it possesses great potentialities for good, not alone to the engineering profession, but to the people at large.

Mr. President-elect, if you will rise to your feet I will transfer this honor which I have enjoyed to you. I now give into your hands the gavel of the Society for the Promotion of Engineering Education. Under your guidance it cannot fail to be a fruitful year. I congratulate you and also the Society. Gentlemen, your new President.

RESPONSE OF PRESIDENT-ELECT.

CHAS. F. SCOTT.

The President and a few other gentlemen, who seem to be a committee on securing the next president, have shown their greater ability to persuade than the candidate had to resist. I appreciate the honor, and I appreciate something of the possibilities which this Society has, and which a president at the head of the society has; and it is somewhat this appreciation of the largeness of the possibilities and the obligation which caused me to hesitate. I thought I had given a positive refusal, but they would not have it so. It was only when several of these past presidents, who have vision of what this society has before it in service to engineering and to the country, said they were ready to help and wanted me to be with them and try to be a leader in the realization of some of these possibilities during the next year, that I finally consented.

I explained to them, as I will to you, that my energies are limited and I have urgent duties for the coming year, and that I shall not be able to give to this service all that it deserves and all that I would like to devote to it; but with the help of those who have the interests of the society so much at heart, and want to realize some of its important functions in the great field of engineering right away, I consented to be your leader.

Some of the officers, who have been in close touch with you, say that this Society is one of the keenest and best groups of men to work with. It has some of the sprit of the engineer; the determination to share in doing the great part in the world which engineering has before it and to do that part by the preparation and making of engineers for the future.

I ask that this be not a one-man concern for the next year, but that all join and do their part in performing the great task which is before us.

PRESIDENTIAL ADDRESS.

SOME HOMELY IDEALS OF EDUCATION.

MORTIMER E. COOLEY.

Retiring President of the Society.

In the opportunity which has been afforded me to address you I have felt that I might be justified in placing before you some views arising out of my many years of experience as a teacher; and have therefore chosen for my subject, "Some Homely Ideals of Education." By homely I do not mean rude, coarse, uncomely, unlovely or unadorned. I use the word in its old English sense of meaning plain, simple, severe, chaste, belonging to the home, domestic. The meaning I would have you get springs from the heart rather than the senses, and signifies quality apart from appearance; the things we feel confidence in, love and admire for the good in them.

An Englishman calls his sweetheart a homely woman and thereby pays her the greatest compliment, meaning that she will grace his home and together they will become the heads of a family of the kind which builds up nations and makes them strong and enduring. He is proud of her womanly qualities—those which one feels and knows exist in the dark. For him it is the homely qualities which constitute the basis of real love, respect, and admiration, such as we feel for our mothers.

Every college is a great family, embracing sons and daughters of families widely scattered over our own country and foreign countries. Whatever brings them to college, they should be made to realize as soon as possible what it is their new mother, *alma mater,* can do for them in the few years they are to bide with her; and they should be influenced by her homely virtues, those which make for manly strength and courage, value and merit.

While in college they should become imbued with that spirit which when they leave to go back to their homes, or to whatever places their work in the world may call them, there will go with them the desire to be a good influence in their community; there will go with them eyes to see beyond the glamor of worldly things and to select out of the complexities of life those things which are good for us as a people, the homely things which will make our nation strong and virile; there will go with them the desire and ambition to bring these homely things to the fore, put them in their proper place and keep them there, and so push back behind them the constantly increasing multitude of things which catch and fascinate the eye, which hypnotize us into believing that they are the real things of life.

Some go to college with the idea that it is a finishing or polishing school, and that their chief object is to acquire culture. Culture is a good thing—that part of it which is enlightenment and discipline acquired by mental training. But there is another part which comes from our home life and associations; it more often is inherited. I mean the refinement and good manners found in well-bred people. Culture is also defined as a product of civilization—but in the old dictionaries when civilization meant differentiation from barbarism. Today civilization, in this country at least, would scarcely be considered to add to our culture and refinement and homely qualities.

In the old days we were accustomed to spend our Sundays in the quiet of our homes, to attend church, to strike a trial balance between the worldly and spiritual things of the week. Some took a bath, shaved, and put on a clean shirt, and were nearer their God. Others counted their flocks and learned their children's names; saw their barefoot boys and girls dressed in clean little frocks, shoes and stockings, and off to Sunday School. For one and all it was a good day—the boyhood Sunday of the older men present.

But now we spend our Sundays differently. Compara-

tively few go to church, and the Bible no longer occupies the place of honor on the center table. Today the masses can be roused to religious enthusiasm only by an earthquake or some revivalist who indulges in the most extravagant language and justifies it to himself as the only effective way to reach the people in these modern times. Let me ask you, teachers of our young men and women, to compare the Sabbath teaching of the old day with the Sunday teaching of the new day. Which is better for your children, the plain, simple, unornamented, homely, religious action and thought of the old day, or the ornamented, big-sounding, inflated and acrobatic action and thought of the new day? And this is the direct outgrowth of our civilization, one of the factors in our old definition of culture.

I like to think of culture as springing from the heart, as the flower of the plant grown in the home and school and matured in an atmosphere of refinement, its roots being the homely virtues, such as were possessed by our old-fashioned folk.

I do not want to leave that word civilization yet. I have not a high respect for our modern form of it, particularly in its effects on our ideals of education. Much is being thought about it and written. The editors of newspapers, even, have something to say occasionally; and it is very refreshing to find them forgetting for the moment the commercial end of their business by excluding some highly seasoned morsel craved by a jaded and degraded public palate to say a word in favor of the homely virtues of life.

The Baltimore *Sun,* commenting on a new profession for women, namely, keeping a bookstore, an idea advanced by Professor Earl Barnes, said:

"The insuperable obstacle to the Barnes idea is that though there are no end to the books published and read, the number bought and owned is ridiculously small. Walter H. Page, American Ambassador to Great Britian and a member of a large publishing house, is credited with the statement that

American men spend more for neckties and American women more for buttons, than either spend for books. People no longer seem to care to own books notwithstanding the pleasure the real lover of literature finds in possession.

"Both men and women say they have no time for reading. The automobile, the phonograph, picture shows, newspapers and periodicals, not to mention the endless 'social activities' and sports, absorb the hours formerly given to books. Children grow up without acquiring a taste for reading; their school work is too exacting; it is a verifiable fact that after the fourteenth year a boy seldom has the desire to read. Thus one great life anchor drags ineffective, for so long as a lad loves books he has occupation for his leisure which helps banish loneliness and often keeps him out of mischief."

Would that more editors, men who constantly have their fingers on the public pulse, wrote about these homely things. What a mighty force lies in them to quicken the spirit. What a pity it is that the newspaper can be successful in the commercial sense only by pandering (I apologize for the word) to a craving of the public for the sensational. But they are run to make money. What better evidence of the character of our American civilization can be had than in the apology that the newspapers print the stuff they do because the public demands it.

Let us look at ourselves from another angle. The Springfield Republican, commenting on national defense, inquires:—

"Are Americans deteriorating? President Rittenhouse of the Life Extension Institute says that they are. . . . He is on safe ground in saying that the first essential is men, 'not merely brave, intelligent men, but men who can stand the excessive physical stress and strain of modern war.' Could America provide such an army? he asks, and answers the question by saying: 'Vital statistics indicate that as a body Americans are physically deteriorating.' If the present tendency keeps on 'we will have to depend upon a weak, soft-muscled, flimsy-fibred people for the defense of the republic.'

"This decadence may not be perceptible, he says, yet it is revealed by figures. Mortality from diseases of the heart, arteries and kidneys doubled in 50 years. So in discussing 'preparedness' it is important, he urges, to consider hygiene. 'The American people are specially in need of being taught how to eat correctly and to get the habit of taking natural exercise.'"

Let us have more of that kind of teaching, but in our schools, colleges and universities. More important still, let us have it in our homes where right doctrines should be taught from childhood. But parents are too indulgent. They want their children, those who find time and the inclination to have any children, to live in greater luxury and to have advantages denied themselves as children; or if not that, they shirk the responsibilities of parents in the matter of discipline and are themselves bossed or wheedled into permitting things being done against their better judgment.

What we need in our homes, as I see it, is a reversion to some of the homely things of earlier days when the father's or mother's word was law, and there was no talking back; when quinine was given off a knife blade, and not in capsules to hide the taste; when cayenne pepper was taken in hard cider for a cold; when for white spots on the tonsils burnt alum was shot into the throat from a paper tube with mother's good lungs at the other end of the tube; when after the snow was well off the ground boots and stockings were cast aside and not donned again (except on Sundays) until the first snowstorms next fall; when boys and girls were in such good physical condition that they could fall out of apple trees and encounter all sorts of mishaps without being disabled and sent to a hospital. There was mighty little petting in those days, and one's first thought after a bad tumble with torn clothes was how to escape the probable scolding or whipping if it got to the ears of father or mother.

Compare the young men of those days with the chap just out of college nowadays who rides from his home to a $10 a

week job, for which he receives $50, in an automobile. Then $400 a year was a liberal allowance for college. Now in the same college double and treble, or even quadruple that amount is spent, and this by the son of the father who spent the smaller amount. Is the son any better educated than the father? Is he any better man? Can he do more for his country? What then has been gained by living in greater luxury and comfort, and by doing the many things not formerly required, while in college?

A former professor in the University of Michigan, seeing a restaurant sign reading "meals 35 cents," said to a colleague:

"When I came to Ann Arbor, walking all the way from New England, I lived a whole week on 35 cents."

The young men and women in our colleges today can scarcely believe what I am saying about the old days. It will tax their credulity even more to tell them that not many boys in those days wore either underclothing or overcoats—remember this is a homely address. A boy felt mighty warm with a tippet wrapped half a dozen times round his neck. But they were rugged lads. They grew on the homely things of life. A piece of apple pie in the old pie-cupboard was incentive enough for half a dozen boys to run the race of their lives over the forty rods between the old school house and home—and uphill at that. Compare the foot-race of those days down the cowpath in the lane with the affair of the cinder-path of today. Bare feet with a stone bruise on each heel compelling one to run on his toes, an old pair of trousers full of holes and frayed half way to the knee, a hickory shirt flapping in the wind,—that was the uniform down the cowpath; light spiked shoes, bare legs, running breeches and shirt with a big letter on the front,—the uniform of the cinder-path. The running time was the same, but the country boy, instead of lying on the grass to be pumped up after the race, continued on whistling and calling the cows.

In the old days there was the Little Red School House on the hill. The species has not become entirely extinct. Oc-

casionally one can still be found. The Baltimore *Sun* under the caption "The Modern School and the Little Red Schoolhouse" comments on an interview with Dr. Thomas S. Baker, headmaster of the Tome School.

"The most frequent complaint of the public schools in many states is the lack of thoroughness. So much is undertaken that nothing is done well. In this respect, perhaps, we have not improved upon the little red schoolhouse of fifty years ago. In those schools children were taught to spell, to read aloud intelligently; they were taught arithmetic and geography with thoroughness and the elements of English grammar. In all these things the average graduate of the grammar school of today is deficient. Spelling is becoming a lost art, and comparatively few can read aloud intelligently. As Dr. Baker says: 'Practical education is the catchword which is heard on every side.' The prime object of education, in the multiplicity of ornamental and practical studies, is apt to be overlooked. That prime object is the training of the mind. Teach a boy to think, to reason, instill correct principles in him and he will do the rest—all the rest will be added." In conclusion the editor said: "The subject is of compelling interest."

Indeed it is, or should be, of compelling interest. What university teacher will not say that the boys and girls who come to him have not been taught how to study. Lack of thoroughness in preparation and not knowing how to study will account for the majority of failures in college; and surely it must also extend beyond college and account for many of the failures in life.

One great fault in our method of teaching, as I see it, is that we teach too much. We are prone to make the subject so simple that no brain work is required to understand it. Information, like bitter medicine, is put into capsules to be swallowed easily and without taste. Students should learn rather than be taught. The teacher should guide and expound, being always careful not to do the work the student should

do for himself. He should be the helmsman who steers the ship—not the power which propels it.

A college education should be to train young men and women to live their lives to the best advantage among their fellowmen, rather than to learn specific things. A perfect mind, like a perfect body, can be developed only by exercise and training.

The world demands men and women who can think independently rather than those who can think only as taught. The world progresses by development of new ideas rather than by the continued application of old ones. Individuality, integrity, independence of action, self-reliance, the ability to create, are all important elements of success in the world's work. Success is not measured so much in dollars as in the respect of one's neighbors.

We need to shape up our mental vision, to see more than is revealed in the classroom and laboratory. We should work to a plan of which studies are but details. It should not be forgotten that professors, profound though they be in their knowledge of specific subjects, are not examples to be followed in tackling the outside world—certainly not in a money-getting sense.

Let me call attention to another phase of our college life:—Less than 50 years ago there were comparatively few tailor shops, and ready made clothing was not the vogue it is today. The wool sheared from the sheep in the spring was sent to the woolen mill in the summer, and in the fall the sheepsgray cloth, a great roll of it, was worked into trousers—they were then called pants. And what pants they were! Mother made them off the same paper pattern for all the boys except that the legs were cut off in lengths to suit. When done they were so stiff they stood alone; they did not need to be creased and hung by the bottom to prevent bagging. One pair a year was the allowance and the same pair served for both ordinary and dress occasions.

Now what do we see? Boys with several suits of clothes,

and pressing shops around the corners; trousers shortened to come above the shoe tops, not from natural wear, but by careful rolling and pressing. Dress suits for evening functions with patent leathers and kid gloves for dancing. This is all very well, perhaps, and in keeping with modern ideas. But another side to it may be seen in many families of wage earners. To illustrate by an actual case, that of a locomotive engineer earning $175 a month. His son was complaining of hard times and the high cost of high living. He could not have everything he wanted. His own little earnings of $12 a week was but a pittance. His clothes, ties, silk stockings, and other impedimenta of the social game, together with flowers, cabs, and after theatre suppers, absorbed his own and a considerable part of his father's earnings. The sad part was that it seemed perfectly natural to him and proper that his father and mother, when they went out for an evening, should ride in the street car and be content with simple and homely things.

Even in our colleges most celebrated for their democracy and where many hundreds of students work to pay part of their expenses, there has been a manifest tendency in recent years towards greater elaborateness in social functions. While to dress in conformity to society's demands is proper and commendable, even a duty when one steps into society where it is customary, I query whether among students from all walks of life for some of whom the expense is a hardship, or quite impossible, it should come to be regarded as a necessity. Should we not aim constantly towards greater simplicity?

And now a word in behalf of Freshmen. They are away from home for the first time—most of them, and no longer under direct parental control and influence. They are passing from boyhood to manhood, from dependence on others to dependence on themselves. They have come to the point in life where they must begin to build the foundation of their future career. If it is to be brilliant and great, the foundation must be broad and deep. They have brought with them the

materials of construction in various degrees of suitability and preparation. Those materials must be passed through the rock-crusher—another name for the faculty, and the concrete-mixer—another name for the upper classmen, and finally tamped into place. If the crusher and mixer have each done their work, if the materials are clean and the cement is good, the foundation will endure. Then after graduation they may begin to erect the superstructure of their life as the world will see and know it. In the University the world knows nothing of the average boy or girl. Each is merely one among thousands, all children of *alma mater,* striving to win in an obstacle race of four laps, the prize being the diploma handed out on graduation.

Students should be advised to select those studies which will go farthest towards rounding out and balancing their education. This applies particularly to the colleges as distinguished from the professional schools. What this country needs today is more men and women educated for the common walks of life, those whose daily tasks are the humdrum or homely things of life, those for whom the specialist works, and from whom he receives his pay.

We are young, as nations go, a country still in the making. We must not forget the ideals of those who founded it. How homely they were in comparison with the ideals of civilization in which we find ourselves. We need to halt and take a calm look about us. But we must have eyes to see, minds to comprehend, and a sense of comparison going back to, and based on, the simple things of life—not the complex. Such doctrine will be hard to teach, I know, for our youth have grown up in an environment quite different; but our country, it seems to me, has come to the parting of the ways in education; and there rests upon us as teachers the responsibility, not so much to demonstrate text-book problems, as to point the way to the highest ideals of manhood and womanhood.

And finally, let me utter a word on the cosmopolitan life of our American campus, which I fear is not fully appreciated.

In the old days parents who could afford it, sent their sons abroad for travel. It is a fine addition to one's education to come into contact with other peoples and to sense something of their point of view. We Americans have lived a life altogether too provincial. But a change now confronts us; and however much we may regret it, we must henceforth take part in the game of nations—the oldest game on earth. What better place can there be than a college campus for the development of the high ideals so necessary if the peoples of the earth are to come together in peace and understanding? We cannot all of us go to foreign lands. Let us then make more of those who come to us from foreign lands. Let us encourage them to come to us in ever increasing numbers, and after biding with us for a time, return to their own countries to preach our ideals of friendship, until finally there shall be spread throughout all lands more of that understanding without which there can be no enduring peace.

ADDRESS OF WELCOME.

BY ARTHUR TWINING HADLEY,

President of Yale University.

No society ever had before it a larger and more urgent task than yours. The country has waked to the need of having skilled engineers of every kind in vastly greater numbers than it ever had before. Past methods of training in engineering, as in chemistry and almost every other form of applied science, have been adapted to the teaching of a relatively small body of students. We have not professors enough to train by these methods the large body of men the country demands, and cannot get them without withdrawing more first-rate men from practical work than we can afford, or think we can afford, to spare. For the first time in the nation's history we have to face the question of national education in its entirety. The problem is not what training would be best for the individual engineer, but what system of training will keep the ranks of the profession full now and hereafter. This is the question which societies like this must solve. Educational institutions can contribute their part toward its solution by showing how they can make their individual appliances do the most work. But the big question of adjusting the character of our education so that the supply of engineers shall equal the demand must be solved by bodies like this.

I shall not attempt to forecast the form which the solution will take, but I can clearly indicate one or two things about it. First and foremost, any system of education that will be wide enough to meet the national needs must expect more of the student than it does at present.

From bottom to top, our education is suffering from kindergarten ideas. The American student has been ac-

customed to get too much help. He relies on the teacher to such a degree as to lessen the teacher's efficiency. He has been so much coddled in the early years of his schooling that when he comes to take up professional education and wants to work hard he often does not know how to do so if he would. Our army experiences in this respect were appalling. Thousands of American lives were lost in the last war because men who were otherwise qualified to be artillery officers could not do sums in logarithms straight unless they had a professor to help them.

Besides relying too much on the teacher we have, I think, made undiscriminating use of our laboratories. A laboratory can serve two or three quite distinct ends. It is a high grade manual training instrument which can teach the general student the use of hand and eye. It is a potent instrument of discovery where the investigator can find out things that were not known before. Each of these uses is admirable, and the more we can have of them the better. But there is another intermediate use which is not nearly so admirable —the use of laboratories for pseudo-discovery. From the kindergarten through high school and college to technical school, there are teachers who encourage a student to go through the motions of discovering a thing in order that he may remember the principle, and lead him to believe that if he has found out a principle for himself he has done better than if he found it out of a book.

I think that the overvaluation of this sort of amateur discovery is one of the worst features of American education. It is undoubtedly true that the use of physical and mechanical experiments makes it a great deal easier for boys to remember physical and mechanical laws. They pay an attention to the experiment that they do not pay to the book. But this does not prove that we can afford to excuse them from making the effort that is involved in intelligent reading. We can well allow a class an opportunity for one or two *illustrative* experiments. We can let a man see how sodium behaves under certain conditions. But it is a great waste of time to

have him repeat the same experiments about potassium and lithium and other things of the same sort because the really attentive reading of things that are set down in printer's ink is too much like work and too little like play.

A century ago we gave the pupil books and little else. There were very few schools indeed where he had much help either in the way of apparatus or of teaching. The men our schools produced were self reliant but uninstructed. But today there are many lines in which we go to the opposite extreme—giving them so much apparatus and instruction that they do not learn how to use books for themselves. Such men are instructed but not self reliant. This extreme is almost as dangerous as the other, and a great deal more expensive. It is for a society like this to find the middle course between the two extremes, which shall give enough help and not too much, which shall teach the pupil to use books for the things where books are needed, and laboratories for the things where laboratories are needed, and to use both of them for himself. In this way, and in this way only, shall we solve the problem of providing the country with the engineers that it needs with the forces at our command.

ENGINEERING AT YALE—RECENT DEVELOPMENTS.

BY J. C. TRACY,

Professor of Civil Engineering, Yale University.

INTRODUCTORY.

A guest is naturally interested in his host, where he lives, what he does, and of what he thinks. A similar interest probably explains why it has become customary for our Society to expect at least one paper from a representative of the college or university which is acting as its host. You will have abundant opportunity to see the buildings of Yale University where we work; it remains for a representative of the University to tell you what we are doing and of what we are thinking. I shall speak only of that which is comparatively new in engineering at Yale, conscious of the fact, however, that these new things which Yale is doing correspond to similar progressive movements in engineering education throughout our country.

REORGANIZATION.

During the past two years Yale has been going through a period of reorganization. Many important changes have been effected throughout the university, but I shall mention only those which most affect engineering. There are six, (1) the division of the entire university faculty into university departments so that any department, as a department of engineering, for example, is no longer a department in the Sheffield Scientific School, but a *university* department which furnishes instruction in any school of the university in which it may be needed; (2) the grouping of departments into four universitiy divisions, one of which is the division of engineering composed of all the departments of engineering; (3) the lengthening of the three-year undergraduate courses in

engineering in the Sheffield Scientific School to four-year undergraduate courses; (4) the removal from the Sheffield Scientific School of all courses whose curricula are not mainly of a scientific character, thus making the school "the university's undergraduate school for the professional study of science and engineering; (5) the replacement of the two separate freshman years of Yale College and the Sheffield School by one common freshman year; (6) the transference of graduate work in engineering from the Sheffield Scientific School to the Graduate School of Yale University.

The Change from a Three- to a Four-year Course.

The change from a three- to a four-year undergraduate course in engineering afforded opportunity for a complete revision of the curriculum. We did not merely add a year to the old three-year course, but we planned the new curricula for engineering courses from the beginning, as if we were starting anew. Our aims were (1) to retain the thorough training in fundamental sciences and non-technical subjects which has always been characteristic of the work of the Sheffield Scientific School; (2) to retain also our technical courses and improve them; (3) to broaden the scope of our work by the introduction of courses pertaining to economics and business, and (4) to interest the students in the profession of engineering from the beginning of the freshman year. We do not claim to have achieved these aims—it is too soon to judge results. In common with other teachers of engineering, we sometimes wonder whether we have not set ourselves an impossible task—the task of giving both a general and a technical training in four undergraduate years. We only know that both kinds of training should be our aim, and if our aim is right, we may contribute in years to come our share in the solution of the common problem.

We spent months in an earnest effort to coördinate the courses in different subjects, particularly in the subjects of the first two years, in order to avoid duplication, to correlate

the work in every subject with the work in related subjects, and to make these early years an efficient preparation for the work of the later years. We have made, I think, considerable progress, but coördination involving, as it does, changes in the view point of many instructors, is a process of gradual evolution even when, as in our case, there is a cordial spirit of coöperation.

In an effort to broaden our curricula and to meet the insistent demand that engineers should have business training, we have done three things:

1. We have introduced courses in such subjects as economics, accounting, business finance and business law. These studies are required of *all* engineering students. To gain time for the introduction of these subjects, some of the subjects formerly given in the regular college year have been transferred to summer courses in engineering.
2. We have broadened the work in engineering subjects themselves to include as much as possible of the larger and more general problems in engineering economics.
3. We have established a new four-year undergraduate course in Administrative Engineering.

The New Freshman Year.

A student who now enters the first year of the university does not become a freshman in Yale College or a freshman in the Sheffield Scientific School, but a freshman in *Yale University*. He is not required to decide which of the two undergraduate schools he will enter until near the end of his freshman year. He thus has an opportunity to become acquainted with the different courses and the conditions under which they are given in each of the two undergraduate schools, and to learn something of the character of the work and the requirements in different professions and occupations. It is, in short, an opportunity for the student to find himself.

Although the freshman year is, so to speak, the common property of Yale College and the Sheffield Scientific School, it has its own separate faculty and its own dean. In order

that it may serve as an effective means of turning the preparatory school pupil, accustomed to strict discipline, into a good university student with personal freedom, the freshman year, as now administered, has several definite aims.

1. *Good Teaching.*—Members of the freshman faculty have been selected for their *ability as teachers.* Small divisions give these teachers an opportunity to use efficient methods. It is expected that the standard of scholarship will be steadily raised and that students who are not fitted to go on with their college courses will be weeded out during this freshman year.

2. *Personal Influence.*—Student councillors under the direction of a head councillor exert personal influence. Each councillor aims to be the friend and guide of some 15 or 20 students. They know when their students are ill, they keep in touch with their families and they represent their students, if necessary, when faculty action is impending. These councillors, moreover, acquaint the freshman with Yale traditions, help him to start right in his college course, and to gain something of the Yale spirit. As the freshman year goes, so go the remaining three years with most students.

It may be asked if the curriculum of this new freshman year is not different from that desired in a first year of an engineering course. The answer is that before this new freshman year was established, we had planned the first year for our new four-year undergraduate courses in engineering, and the curriculum for this first year was adopted almost intact for students in engineering in the new freshman year. It may be that in the future the present curriculum of the freshman year may be changed, but it is believed that the advantages of the new plan far outweigh any disadvantages which may result from modifications which may be made.

The New Course, "Introduction to Engineering."

During the past year a course known as "Introduction to Engineering" has been given to all freshmen who expected

to enter engineering courses. The first aim of this course was to give a general knowledge of the whole field of engineering. This was done by a series of introductory lectures in which the work of the engineer was outlined, the advantages and disadvantages of the profession were discussed, the qualities desired in an engineer were considered, and the aims in engineering education were explained.

The second aim was to give a knowledge of the work done in each of the four principal branches of engineering. For this purpose students were divided into small groups and each group was taken in turn for six or eight exercises in each department of engineering. Lantern slides, photographs, drawings, various exhibits of engineering materials, laboratory exhibits and inspection trips were all used to illustrate the work in the various branches.

The third aim was to convince the student that the subjects which he studies during the freshman and sophomore years are actually used as tools in engineering. This was done by constant reference to these subjects in explanation of engineering work. By the time that a student had heard 30 or 40 different engineering instructors explain how these fundamental subjects are used in different lines of work, he began to be convinced that he himself would need to use them later on.

The fourth aim was to help the student determine, first of all, whether or not he was fitted to enter engineering, and later on in the sophomore year to help him also to choose between the different branches of engineering.

Voluntary replies to a questionnaire from more than 100 students showed beyond question that these four aims were to a large extent attained. To wake up, look about him and see the world in which he lives, with its problems and its opportunities, is what many a student needs to do in order to gain an incentive for his college work. To help the student do just this was after all the main object of the course.

Course in Engineering in the Sophomore Year.

In order to foster the interest in engineering aroused in the freshman year, a course in engineering is given to sophomores. In this course the work is of a more technical character and includes in the first term a general course in power given in the department of mechanical engineering and in the second term a similar course in the transformation of power from mechanical to electrical and the reverse, given in the department of electrical engineering.

Summer Courses.

Each student in engineering is required to take four weeks of summer work in each of his three vacations. All students in engineering are required to take an elementary course in surveying during the first summer. Advanced courses in this subject are given to certain engineering students in subsequent summers. In addition to field work, certain classroom subjects, such as elements of railway engineering and elements of highway engineering, formerly taught during the regular college year are now taught in summer courses. Students in the electrical, mechanical and administrative engineering courses are given a course in mechanical technology during the second summer in which they are taken on visits to local manufacturing plants and power plants in order that they may become acquainted with the terms, processes and equipment used in these plants, and at the same time be brought in contact with the industrial atmosphere. This course is not merely one in shop inspection, but students are required to make sketches, render reports, and solve definite problems.

The Sheffield Scientific School has purchased a tract of land 3½ miles long and 2½ miles wide to be used as a site for a summer camp of engineering. Plans have been completed for permanent buildings to be erected on this site, and it is hoped that these buildings may be constructed during the coming year. This engineering camp is intended not for the

use of students in any *one* department of engineering, but for the use of students in *all* departments of engineering.

Course in Administrative Engineering.

It has been said that the number of distinguished Yale graduates who are following engineering, pure and simple, is relatively small. If this is so, I think the explanation is that many of our graduates who become successful engineers are drafted, so to speak, for responsible positions in industry. Thus, for example, of the 15 officers and members of the executive committee of the Yale Engineering Association more than half hold executive positions in industry, including such positions as presidents and vice presidents of many of the largest corporations in the country. Statistics show that a very large percentage of our engineering graduates become executives. In response to a demand which had become insistent, we have established a course in administrative engineering, the object of which is to prepare men for executive and managerial positions for which a knowledge of engineering principles and methods is requisite. The course is not intended for those students who expect to become professional engineers in the field of design and construction, or for those students who expect to fill executive positions in which a knowledge of engineering is required equivalent to that ordinarily gained in any one of the regular engineering courses.

Without going into details of curriculum, it may be said that the first two years differ very little from the first two years of the other engineering courses, and in these two years students are given an opportunity to develop the scientific method of attack, as well as to study such general subjects as English and history.

In the junior year the work is largely engineering and centers about two subjects, power and machinery. The aim in these courses is not so much to teach students to *design* machines, power plants and power distribution systems as

it is to teach such fundamental underlying principles as will enable them to *use* power and machinery more efficiently. An executive does not need to design, but he does need to understand what his designing engineer is doing.

The senior year includes less engineering and more subjects pertaining to business administation, such, for example, as industrial management, statistics and reports, specifications and contracts, and business law.

We are well aware of the dangers of such a course. We know that it is going to be difficult to retain the analytical training which enables the engineer to attack successfully a single problem however large and at the same time to furnish the more general training which enables the executive to correlate a great variety of problems and attack them as one general problem. On the other hand, it may be pointed out that in the old type of engineering course students who had no intention of becoming creative engineers not only studied many highly specialized subjects which were of little value to them in after life, but, absorbed in details, they often failed to gain the training necessary for the broader outlook required in later years.

There has been established another course, known as Science as Applied to Industry, which has aims similar to those of the course in Administrative Engineering, but in place of engineering subjects, the emphasis is on such subjects as chemistry, geology and metallurgy.

TRANSPORTATION.

Lord Strathcona's bequest of a considerable sum of money to be used for instruction and research in problems pertaining to transportation brought to the University additional responsibility and opportunity for contributing its share to the solution of the whole great problem of transportation—railway, highway, water and aërial. To meet this responsibility Yale must coördinate all of its resources including engineering on the one hand and economics on the other.

To secure the man who can do this will be difficult, but a professorship in transportation has been authorized and it is hoped that eventually the right man may be secured for this professorship.

Graduate Work.

During the transitional period our requirements for the higher engineering degrees, C.E., E.E., M.E., and E. of M. remained as before, two years of work in residence or one year of work in residence plus practical experience. During the coming year both the requirements and the degrees themselves may be changed. For the past two years the average number of *graduate* students in engineering has been forty-four. Our graduate work is highly organized and supervised. A feature of the work is the appointment of engineering specialists of national reputation to give regular courses of lectures. In some departments, this work is in the nature of conference courses in which the specialist meets graduate students in a round-table discussion, devoting an entire afternoon to each of these discussions. Our proximity to New York and other large cities of the East enables us to secure high-grade men for this work.

Yale Engineering Association.

Much of the recent progress in engineering at Yale has been due to the work and influence of the Yale Engineering Association. It is a pleasant thing to express our appreciation for all that this Association has done to help us. Such an organization actively coöperating with the faculty is one of the greatest assets an engineering school can have.

New Vision and Enthusiasm.

I have confined myself as I said I would to that which is comparatively new in engineering at Yale. The topic was not of my own choosing, in fact, it was somewhat distasteful to me, not merely because I naturally shrink a little from

talking over much about the work of my own university, but because I believe that the most essential part of engineering education is not new, but old. Success does not depend on new forms of organization, or on new curricula, or on new methods of work. There is no royal road to successful teaching any more than there is a royal road to learning. Nevertheless, progress means growth, and we ourselves must grow as the years pass by. We must dream new dreams and gain from time to time new inspiration.

Possibly the greatest single achievement in engineering at Yale during the past few years has been the development of a new vision, a new hope and renewed enthusiasm in the engineering faculty. This is not peculiar to Yale—it is the common heritage of the times for all engineers. The question is no longer, if it ever was, are there great opportunities in engineering—the real question is how shall we meet the responsibilities which these great opportunities bring. This, I take it, should be the question ever uppermost in such a convention as this.

ALUMNI ENGINEERING ASSOCIATIONS.

BY F. C. PRATT,
Vice-President General Electric Company; President Yale Engineering Association.

Speaking on behalf of the Yale Engineering Association, it gives me great pleasure to welcome to Yale the members of the Society for the Promotion of Engineering Education at this, the Twenty-ninth Annual Meeting of the Society.

While the practice of engineering is of ancient origin, yet, through the tremendous growth of public utilities, manufactured products and transportation, a new relation has been established between engineering and our modern life. Our people and our civilization are dependent upon engineering to an extent never before realized, and progress and prosperity look to the work of the engineer, in ever widening fields, for their continuance. The World War brought so conspicuously to the attention of the general public the indispensable services of engineers, that it has since become a relatively easy undertaking to incite interest in engineering education.

Your Society, founded at the time of the World's Fair at Chicago in 1893, however, has the honorable record of having persistently, wisely and effectively lent its best efforts to the promotion of engineering education over a period of twenty-eight years.

I have been asked to say a few words to you in regard to the helpful work which may be done by an Engineering Association of Alumni, and in order to establish a perspective of the present status of engineering at Yale, I want to point out a few milestones which mark the long course of the history of Yale, and to call your attention to a few statistics taken from recent publications of the Yale Engineering Association:

The founding of Yale dates back to October, 1701, when a charter from the Colony Legislature for the Collegiate School of Connecticut, was granted to a few of the ministers of Connecticut.

As pointed out in an article by Dean Cross which recently appeared in the Yale Alumni Weekly, Benjamin Silliman was appointed Professor of Chemistry and Allied Sciences in 1802, at which time he fitted up a rude laboratory for his experiments. In 1820, more suitable quarters were provided for the laboratory.

In 1847 his son, Benjamin Silliman, Jr., and John P. Norton, both of whom had received appointments in Chemistry, set up another laboratory in the kitchen of the abandoned "President's House" on the old campus, for experimental work, designed mainly for graduate students.

"Norton . . . was succeeded by John Addison Porter as Professor of Analytical and Agricultural Chemistry. Later was added to the staff, Samuel W. Johnson, who became the most distinguished chemist of the group. (Professor Johnson was the father of agricultural chemistry, and it was largely through his efforts that the first agricultural experiment station in this country was established in New Haven.) From this 'School of Applied Science' as the outfit was at first called, sprang the 'Yale Scientific School,' and in 1860, the 'Sheffield Scientific School.'"

"The Sheffield Scientific School is the University's undergraduate school for professional study in science and engineering, having its separate funds, buildings, teachers, and regulations, but governed by the corporation of Yale University, which appoints the professors and confers the degrees." It should also be borne in mind that the university funds are available to supplement those of the school, and that a large part of the instruction is given in the great university laboratories, particularly in physics, zoölogy and botany.

There are today over 6,000 living graduates of the Sheffield Scientific School.

"Engineering graduates comprise 54 per cent. of all Sheff. graduates in recent years (1907–1917).

"Engineering graduates comprise 25 per cent. of the combined total from the Scientific School and Yale College for the same period.

"The percentages of increase in all Yale graduates for the fourteen years from 1904 to 1916 are as follows:

"Law, Medicine, Ministry and Teaching, combined, 24 per cent.

"Manufacturing, Finance and Mercantile pursuits, combined, 83 per cent.

"Engineering, 160 per cent.

"Students in the engineering division of the 1919 freshman class of the Sheffield Scientific School comprise 65 per cent. of the entire class, and 28 per cent. of the freshman class of the scientific school and Yale College, combined.

"Engineering students in the Graduate School of the University comprise 18 per cent. of the total, exceeding in number any other group."

I think that these statistics strongly emphasize the increasing interest in engineering education at Yale, and point out the necessity for the broad, constructive work which is being done, in order that the university may adequately meet the demands for the best engineering education in both the Sheffield Scientific and Graduate Schools.

The Yale Engineering Association was organized on December 4, 1914.

The headquarters of the Association is at the Yale Club, New York City.

The Association's membership consists of ordinary life, sustaining, and honorary members. The Association has today over 1,000 members, thus possessing a larger membership than perhaps any other one organization of Yale alumni.

Article II of the Constitution, in referring to the objects of the Association, states:

"The objects of this Association shall be to advance the interests of engineering education at Yale and to promote the better acquaintance and fellowship of Yale engineers.

"In working toward these ends, it shall endeavor to establish closer relations and coöperation between the engineering departments of the Sheffeld Scientific School and Yale graduates engaged in active engineering practice, to bring together the older graduates already established and the younger men entering upon their professional work and to take such other action as may from time to time seem advisable to promote the welfare of engineering interests at Yale and of Yale engineers."

The Association functions through the usual officers, the executive and other standing committees, including by-laws, consultation, curriculum, employment, meetings, membership and publicity committees. Special committees are also appointed from time to time by the executive committee or the president, according to circumstances.

The Year Book of the Association gives not only the usual information in regard to the officers elected for the current year, the personnel of the standing committees, the annual reports of the officers, and membership lists arranged both alphabetically and geographically, but also reviews the work of the Association during the past year and records certain addresses and communications which relate to the questions of engineering at Yale and to the affairs of the Association.

Periodic "News Letters" are issued by the Secretary and sent to all members for the purpose of keeping them actively informed in regard to matters which affect the objects of the Association. These publications frequently include letters from members of the engineering faculty giving the latest information in regard to organization, new courses, and other improvements which may have been introduced with relation to engineering education. Each News Letter covers from eight to ten printed pages, and it may be of interest to note that this form of communication has since been adopted by the Princeton and Harvard Engineering Associations.

Conferences are held between members of the faculty or the corporation and members of the standing or special

committees of the Association on matters affecting the interests of engineering education at Yale. These conferences are of frequent occurrence, and the faculty are constantly turning to the Association for advice as well as for its influence. Among the more important conferences have been those on the general plan for the development of engineering at Yale, later submitted to the corporation; on matters pertaining to the curriculum; on the appointment of new professors; on the new department of transportation; on the establishment of a course in administrative engineering; and on publicity, particularly among Yale's engineering alumni.

Memorials are addressed to the corporation on matters which are considered to be of particular importance.

The booklet, "Engineering at Yale," of which you will receive copies, is the result of collaboration between the university authorities and the publicity committee of the Association, and has been published and distributed at the expense of the Association.

At the present time the Association is very greatly interested in the question of securing a fully equipped engineering camp for summer work, and a memorial has just been presented to the members of the Yale corporation by a special committee of the Association, setting forth the needs for, and requirements of such a camp, for which a particularly advantageous site is available due to the wise forethought of the trustees of the Sheffield Scientific School in purchasing a tract of land at East Lyme seven years ago.

The earnest endeavors of the Association to further the best interests of engineering education at Yale have uniformly met with the most cordial and appreciative reception from the members of the corporation of the University, and the governing board of the Sheffield Scientific School.

The interest of the Association in any special project is sometimes actuated by members of the Association, while in other cases the Association has been invited by members of the engineering faculty to lend its assistance to some undertaking. I think it safe to say that through its influ-

ence with the Yale corporation and the administrative officers, the Association has been helpful in getting things done which needed to be done in the interests of engineering education; that the large body of alumni, constituting the membership of the Association, has been kept much better informed in regard to the constructive work which is constantly being done to improve and strengthen the engineering courses at Yale, than would otherwise have been the case; that a better esprit de corps has been created among our alumni; that great benefit has resulted from bringing members of the faculty into conferences with members of the executive and other committees of the Association to their mutual advantage.

The engineering alumni stand in a unique position. They are in the world of activity and progress; they sense the new needs for trained men. The engineering faculty needs their stimulus and spiritual leadership and even more the University corporation needs the enlightenment of the alumni, as their knowledge of engineering was gained years ago and the present activity of most of its members lies in other fields.

A Yale alumnus takes great interest in Yale and the Yale Engineering Association is particularly the vehicle of expression of the engineering alumnus for repaying his debt to his alma mater in constructive assistance.

It seems to some of us that what the Yale Engineering Association has done is not a little thing but a big thing. It is the beginning in a broad way of what should be a matter of very great nation-wide importance, *i.e.*, the active concern of those interested in engineering in advancing the education of the coming generation by raising and dignifying the educational standards, and publishing the importance of a high order of engineers and of engineering training.

I know of no group of men who can more effectively assist in the attainment of these ideals, than the members of your Society.

The members of the Association have been very much encouraged in their earnest desire to see engineering education at Yale put upon the best possible basis by action taken by the corporation in establishing a division of engineering, as one of the four divisions in the university faculty, and in increasing the number of engineering professors, also by election to the corporation by the alumni of the University of Mr. Herr, who was the first president of the Association.

This Association gives each graduating class an opportunity of at once coming into immediate relations with an alumni organization of a kind which should be helpful and inspiring.

In the words of one of our past presidents, Mr. Covell, "The Yale Engineering Association is first for Yale, then for Sheff., and last, but not least, for engineering and all that it implies."

We believe that the Yale Engineering Association is a good thing for its members and for Yale, and I can see no reason why similar associations should not be mutually beneficial to other universities and technical institutions, and to their engineering graduates.

I thank you for your attention, and sincerely hope that this visit to Yale may be most interesting and enjoyable to all of you.

COLLEGE EDUCATION AS RELATED TO INDUSTRY.

BY J. E. OTTERSON,

President of the Winchester Repeating Arms Company.

The student and the pedagogian are primarily interested in the processes of education: the industrialist is primarily interested in the product of education. The student gains the impression that the purpose of education is the acquisition of knowledge. To my mind the acquisition of knowledge is of secondary importance as far as the use of the product is concerned. The important thing is rather the development of mind and of character, the development of those mental processes which make it possible for the student to subsequently apply himself intelligently to any problem which may be presented to him.

The encyclopædic type of mind is not always that best suited to the practical purposes of industry, notwithstanding the fact that we have had recently much discussion of a test to which applicants for industrial positions might be put. The proponents of this kind of test have not informed us whether the examination constituted a basis of rejection or of selection. From my own observation I am rather convinced that one who could make a high mark in such a test might fail lamentably in meeting the practical tests and problems of industry.

We are more concerned with the qualities of mind in the nature of Imagination and of Constructed Ability, than we are in the quality of retaining knowledge which may be unrelated to the practical problem which is put before us.

Furthermore the student is likely to get the impression that education is an end in itself, and having acquired a college education, that his work in life is complete, rather than only

begun. From an industrialist's point of view a college education is not an end in itself—it is merely a means to an end and a tool which may make a certain end possible.

If we are to proceed on the theory of merely acquiring knowledge, we are likely to develop a kind of mental indigestion which makes it impossible for the sufferer from this complaint to apply himself to a particular problem, because of the confusion of facts constantly passing through his mind.

In measuring any force we are concerned with two components—its magnitude and its direction. I think so far as the force which has been brought into the world through college education is concerned, that we need not worry about its magnitude; but I think we might concern ourselves somewhat with its direction.

Most of our college students with whom I have come in contact in connection with their application for industrial position, have acquired a good engineering knowledge, and they have good qualities of mind and good intention; but they lack direction: they lack knowledge of the end they are seeking. They have failed to put themselves through a self-analysis to determine the character and the quality of work they are capable of doing. And in making this examination it rests not particularly upon the kind of work that they happen to excell in in connection with their studies but rather with these natural qualities of mind and character which go to make up the man, rather than the student. Those qualities of mind and character may very well be obtained to even a more marked degree by processes of education other than those of the college; and so it is that we frequently find that the man who has gotten his education by passing through the practical work of the shop, and through the school of hard knocks, has developed that kind of character which causes him to excel in industry.

In industry I have observed, and I think it is true, that the majority of men who occupy responsible positions have come through the shop, through the practical course of training rather than through the college. This is partly

due to the fact that there is a greater number of applicants and candidates available who have taken the practical course, than there is of those who have gone through the college course, but frequently it is the practical training that has given them the qualities of mind and character which make for their industrial success.

I have no suggestions to make as to amplification of the processes of college education. I have no doubt they have been well worked out and are fitted to the purpose of acquiring an education or to the imparting of knowledge. But I think we might go a little further in our college treatment of the student before his graduation in an effort to assist him in performing that self-analysis which will enable him to go out into the world in the proper direction.

I imagine that if you examined the careers of a number of college students you would find that for a considerable period after graduation they had worked without much direction and that their ultimate work in life was not necessarily that for which they were trained in college, or which they followed immediately after their college course but it was that into which they were led by their natural talents and qualifications of mind.

It is not possible in so short a talk to go into the question of psychology of men or the division of men according to the psychological processes; but I think something might be done for the college student in the way of subjecting him to psychological tests throughout his college career to determine in what direction his talents were developing. And we might then assist these men into their proper channels subsequently.

For this purpose I would like to suggest two broad divisions of men, namely, (1) engineers, and (2) executives.

The engineer is a man who is capable of working in a concentrated way upon a single problem for a protracted period of time. He does not care to be disturbed by other matters unrelated to the problem in which he is at the time interested. He is interested in the development of engi-

neering law, formulæ and facts. He deals with facts rather than human beings.

The executive, on the other hand, deals with a multitude of problems at one time. He has but a few minutes to devote to each. In some instances he has available the work and the conclusions of the engineer, in other cases he must rely upon his judgment, his intuition and his experience. He does not find it possible to concentrate for a considerable period of time upon one problem; but he enjoys the variety in his day's work. He wants to do many things and get them done. He is not so much interested in the method or in the accuracy of the method, as in the result. This type of man is interested in human beings rather than in abstract facts. And these two types of men are generally quite different in character. And it seems to me that the college-boy needs direction of this kind. I do not care what kind of engineering training the college graduate has had—whether he is a civil engineer, mechanical engineer, an electrical engineer, is of no interest. If he has had a general engineering training and has the qualities of an engineer, employ him as such. If he has the education of an engineer and has the qualities for an executive, then employ him as such.

In other words I am suggesting that ultimate employment follows the line of psychological qualifications rather than the line of technical training and we should provide facilities in connection with our college courses to determine the student's psychological qualifications to the end that he may more quickly reach his ultimate work in life, and not waste his time and energy in the pursuit of work for which he has no psychological qualifications.

I would like to suggest therefore, to this body that it work to the end of further developing the facilities for giving the student proper direction upon his graduation in order that the tremendous potential force and power that lies dormant in so many of our college graduates, may be more quickly awakened and directed to useful purpose.

DISCIPLINE VS. CULTURE IN COLLEGE.

BY GEORGE F. SWAIN,
Gordon McKay Professor of Civil Engineering, Harvard University.

In preparing a short paper for a meeting at Yale University, my thoughts instinctively dwell on one of the really great figures that have graced this seat of learning, a man whom I consider one of the greatest thinkers that America has produced, and whose teachings at Yale have, I think, been one of the most beneficial influences that have affected the past generation or two of its students, William Graham Sumner. His influence at Yale lives yet in his pupil and successor, Albert G. Keller, and in all who have felt the magic touch of Sumner's relentless logic. I wonder if any of you know Sumner. If not, the best contribution that I, or anyone, could make to this discussion, would be to introduce you to him. If you have not read him, you will find in the four volumes of his essays, published by the Yale University Press, and in his other works, a mine of wealth on matters connected with sociology, economics, and education.

Recently I have been reading one of those volumes. In fact, I read Sumner almost every day. My mind goes back at once to his essays on Discipline, on Integrity in Education, on Purposes and Consequences. You must not be surprised therefore, if in what I shall say you find a good deal of Sumner. If it were all Sumner it would be an improvement. My earnest advice to you is to get acquainted with him.

Culture is considered by many to be the main object, or result, of college education; discipline by others; knowledge by others still.

It all depends, like other things, on the definition. "Define everything and prove everything" is the basis of logical thinking. Let me begin by quoting Sumner.

"Culture is a word which offers us an illustration of the degeneracy of language. If I may define culture, I have no objection to admitting that it is the purpose of education to produce it; but since the word came into fashion, it has been stolen by the dilettante and made to stand for their own favorite forms and amounts of attainments. Mr. Arnold, the great apostle, if not the discoverer of culture, tried to analyze it and he found it to consist of sweetness and light. To my mind, that is like saying that coffee is milk and sugar. The stuff of culture is all left out of it. So, in the practice of those who accept this notion, culture comes to represent only an external smoothness and roundness of outline without regard to intrinsic qualities." After mentioning several kinds of culture, Sumner adds what he calls "sapolio culture, because it consists in putting a high polish on plated ware." He adds: "There seems great danger lest this kind may come to be the sort aimed at by those who regard culture as the end of education."

If by culture is meant getting an acquaintance with the best that has been written and spoken, nobody will deny that this is desirable. But it seems to be a very minor part of what education should be. Acquaintance of this kind will help a man but little, unless his powers have been trained to use it, to meet the problems of life, to really accomplish something.

Discipline, on the other hand, means such training as will bring into intelligent activity all the powers of mind and body which will bring the ability to reason correctly, to observe, to concentrate, to attack a problem intelligently, to know what facts are necessary for its solution, and where and how to get them. This is only to be obtained by close application and constant exercises of the powers that are to be developed. It is the result of labor, patience, and self-denial. It does not come from listening to lectures, or reading books

merely, or learning what other men have said. It will not come to a student who sits in a lecture room listening to other people talk, and who plans his curriculum on the basis of doing only what is necessary to get through. The knowledge that Goethe said this, or Dante that, or Aristotle something else, is interesting, but does not give discipline.

The value of discipline is that the man whose mental powers are properly trained can concentrate them on any problem that is before him, whether new to him or old. A new problem is only an occasion for the application of old and familiar processes. Discipline, therefore, cultivates that rare quality, mental courage, gives a man self-confidence, makes him realize that we live in a world of law, and that wisdom consists in studying those laws and learning to live in conformity with them. Discipline, therefore, trains character, while acquaintance even with the best that has been written does not of itself accomplish this result.

Sumner somewhere says "I never see anything more pitiable than the helpless floundering in a new subject of a young man far on in his education, who has never yet learned to use his mind," that is, one who may be cultured but not disciplined.

Here I must direct your attention to another striking and very true observation of Sumner, of which, he says, we continually lose sight, and of which culture is an illustration, namely, that "the great and heroic things which strike our imagination are never attainable by direct efforts. They come as the refined result, in a secondary and remote way, of thousands of acts which have another and closer end in view. If a man aims at wisdom directly, he will be very sure to make an affectation of it." If he aims at culture directly, he will perhaps merely put a superficial polish on poor material.

It is not clear that what is needed in education—what should be its main purpose—is discipline, a training of all the powers of the man. If this is what is meant by culture, well and good.

This discipline should be exercised on suitable objects, and in a suitable way. It cannot come by absorption through the pores. It requires hard work, and interest in a subject can only come from a sense of personal profit that will result from the study. It should be accompanied, of course, and incidentally, by the acquisition of knowledge. Discipline should, of course, be trained on subjects that will also give knowledge, develop character, afford a background of philosophy that will enable a man to fight the battles of life with courage, hope, and faith.

The main point is that the object should be discipline, and not what too often is sham and dilettanteism, parading under the name of culture.

SOME FEATURES OF ENGINEERING EDUCATION.

BY W. H. BURR,
Consulting Engineer, New York City.

One may reasonably be surprised, if not bewildered, in looking over the Bulletins issued by the Society for the Promotion of Engineering Education and the Annual Reports of the same body, to observe both the range and the quality of the observations made for the purpose of advancing the efficiency of engineering education. Indeed, both the scope and the range of subjects covered by these observations are so far-reaching and so varied that one wonders whether there is any point of stability in the whole field. The variety of suggestion and the range of subjects from the most fundamental and important to the inconsequential and commonplace seem to indicate that no two individuals, either teachers or practicing engineers, have any substantial thing in common. In other words, the whole field of engineering education seems to be in a dynamic condition, or perhaps one may better put it as a state of violent ebullition without any surface evidence of having stable strata at any depth whatever.

This seems unjustifiable to an experienced and careful thinking engineering practitioner in spite of the fact that the character of his practice is quite rapidly changing in these days, but essentially by gradual development to meet the demands of the community increasing in population and correspondingly extending its interests as well as to take advantage of advances in different lines of scientific work which contribute to the efficiency and refinement of his professional practice. One would suppose that such an unstable state of engineering instruction would trouble the

teacher by depriving him of any element of stability in his annual program, but it sometimes seems as if he rather revels in these educational novelties.

It is true that changes of subjects and some variations in the manner of teaching the fundamentals which cannot change greatly from year to year, are necessary in order to meet the growing requirements of the profession. Such changes however are of what may be called the advancing kind which always have taken place in all engineering instruction and must always continue to take place. In fact, their absence would indicate that the instructor could not be alive to his responsibilities. Such necessary and wholesome developments take place in the teaching of every profession, whether of engineering, law or medicine. It may be safely stated, however, that in no professional instruction other than that in engineering is there any such topsy turvy mixing of its elements as that now being exhibited in the engineering field and evidenced in no more conclusive manner than by the publications of this Society. In some important respects this condition need not be considered as injurious to either engineering education or to the profession of engineering, broadly speaking, *i.e.*, if this violent educational ebullition so to speak, is wisely guided and developed so as to contribute to the attainment of higher excellence in both the educational preparation for professional practice and in that practice. One would be rash indeed to state that such a desired end will result, or is even being remotely approached. As a matter of fact for the time being the motion is away from excellence in each of those results and at some points speed is being made toward crudity and marked inefficiency.

It is full time to take stock of this situation most seriously, both as to engineering education as it is now administered broadly throughout the country and as to what may be of even more importance, the effect of that education on the profession as a whole and on the characteristics of the individual practitioner. There are some significant signs

of which notice should be taken and which have developed during the past ten years, approximately speaking.

For some reason members of the principal engineering societies and associations of this country are deeply dissatisfied with their professional status as indicated by the failure of the public, as they claim, to give members of the profession proper consideration in their professional work. There have been many meetings, joint and individual, of these societies and associations, for the purpose of discussing this failure to receive sufficient professional recognition from the community at large. New organizations have been created, one of them the largest body of organized engineers in the country, with the avowed purpose of affording the engineers joining it, professional advantages involving better pecuniary rewards and other returns. And more lately a number of prominent national engineering organizations have consummated a kind of association, or limited pooling of interests which it is hoped, coupled with sufficient publicity of the right kind, may induce a much better professional recognition of its members than heretofore. The seriousness with which these ends have been brought about is conclusively significant as to their purpose, if open and unqualified statements of the latter were not constantly in evidence.

Doubtless much can be done to relieve this situation among experienced practitioners in the entire engineering field, but the greatest influence of all is that which can be exerted through suitable and effective professional educational training. If the American Society for the Promotion of Engineering Education had had as a body a true vision as to what it could and should have done in developing wholesome and effective ideas of engineering education, it is not unreasonable to suppose that the present unsatisfactory and disappointing condition of the profession could have been prevented. This was the proper mission of this Society and it has failed fundamentally in it. This Society was organized as an independent body in 1893, contrary to the strong,

although informal remonstrances of a minority of which I was one, on the ground that engineering educational propaganda and work should be carried on in the great national engineering organizations where it would be in constant touch with every member and where consequently it would have the active sympathy and support of these members. Its intimate contact with the interior of the profession, so to speak, would have created a direct and effective influence on the profession impossible of attainment to any material degree in a disconnected and isolated organization. Having been a charter member I shall express my criticisms freely, but reasonably, inviting attention to present conditions, so nearly fatal in their results that engineering education, broadly speaking, is now simply a melange and not a system. This Society owes to itself the recognition of an obligation to reform as far as it can the present conditions of engineering education and undertake the organization of some systematic effort to ascertain what engineering education really means so as to formulate an effective plan for rescuing it from the morass of technical confusion into which it has fallen.

There are certain fundamental principles which should govern education in order to accomplish the purposes for which it is designed. The secondary school, to go no further down the scale, requires the application of principles suited to its purpose, the college similarly needs a curriculum formulated in accordance with such general principles as may serve its purpose effectively, while the professional school, the next higher and crowning part of the educational structure, must have such treatment as will secure for it a curriculum adapted to the most effective educational training of young professional practitioners. At the present time, and therein lies the origin of all our difficulties, the colleges and the professional schools of engineering are made a hopeless jumble which has received the constant sanction and support throughout all these years of this Society, whereas its first and chief duty should have been the pre-

vention of such confusion by guiding the creation and administration of each part of the educational organization to the highest possible efficiency, and thus make those parts effectively complementary to each other. A great majority of the engineering schools of the country are called "colleges of engineering." Obviously the mere name of an educational institution is of quite subordinate consequence in itself. "A rose by any other name smells as sweet," as we know. In the present instance, however, calling a professional school an "engineering college" makes a course of study which ought to be thoroughly professional in character merely a scientific college course, and that is the fatal defect of a great majority of the engineering schools of this country. They are neither professional schools nor are they in reality colleges. They are a kind of hybrid that produces neither the broadly educated college man, nor the educationally trained professional man. Some of them have served well a transition purpose, but the type is far from that of a professional school.

More than seventy years ago the oldest engineering school in America, The Rensselaer Polytechnic Institute, reorganized its professional course of study with a vision as to the future both wise and remarkable. It sought to establish a professional school of engineering and applied sciences by formulating a course of wholly professional study of three years' duration to which college graduates were invited to come for their professional engineering training. It was fully fifty years in advance of the time when such an effort could possibly succeed. The experiences of the first year of this course of professional study showed that it then had no prospect whatever of success. To remedy the difficulty a preparatory year of study was formulated so that non-college graduates could thus prepare to begin the three-year course of professional educational work, making four years in all. This was the origin of the prevailing four-year course of engineering study which has become so general throughout the United States. It would appear that

the idea of basing professional engineering educational training on a broad general schedule of study such as that afforded by the usual college course has somehow dropped out of all consideration whatever, except in a few rare cases. There is distinctly a feeling that something needful is not included in the present engineering courses even in the minds of those who administer and defend them, and their apprehension is too well founded. There is something of the utmost importance lacking. Both students and instructors of those institutions yield, although unconsciously, incontrovertible evidence of that fact. It is only necessary to glance over the Bulletins and Annual Reports of this organization to be convinced of this situation.

If the American Society for the Promotion of Engineering Education should advocate a definite, well-considered plan of professional education for engineers and direct its support to such a plan through its Annual Meetings and publications, it would give confidence and inspiration to the profession and thus greatly influence its reception in at least the leading engineering schools of the country. Fundamental principles calculated to attain such important results would be recognized and set forth to guide the general movement. Details would necessarily vary according to the environment and purposes to be served but the general result of an advanced, well balanced and effective training for engineers would be attained. Manifestly in this day and generation no professional man can consider himself effectively equipped in any educational way without fundamental training in those general subjects which are ordinarily grouped under the name of humanities, or liberal arts, *i.e.*, without any ordinary college training or its equivalent.

I am well aware that many engineering instructors and practicing engineers who are interested in engineering education argue that the engineering profession is in some way so different from the learned professions of the law and medicine in its character that the general type of educational training which they have adopted for entrance into those

professions, is not suitable for the educational training of young engineers. They now require in their best professional schools a broad general education acquired in the college on which to base the professional educational training. Anyone who is observant enough will find that a large proportion and probably the majority, of those two professions who have reached the beginning of middle life are men broadly speaking, not only of technical ability and excellence but who possess what may be termed in the broad sense, cultivation. They can take their places with credit to themselves in any place in the community where they may be called. They possess individuality and those qualities of mind and character which demand and receive public recognition both in and out of their professions. It is not necessary to enlarge upon the lack of such acknowledged position in the community on the part of engineers for they themselves have set it forth within the past few years in clear and unmistakable terms, as I have already indicated at length. All such curative efforts made through engineering organizations, however, are bound to fail in large part as they have failed up to the present time, unless one fundamental condition is first fulfilled and that is, the engineer must have a full professional education as a basis for his professional career before he can properly demand or be accorded by the public, full professional standing. Indeed, if it were feasible to give to every engineer in the country a suitable, professional educational training the profession would in a short time attain to the high position which it covets and be accorded by the public every advantage which it is now striving to attain without any other aid whatever, just as the professions of law and medicine have done.

The high position and the great advantage reached by any profession are actually due to the acknowledged character and attainments of a minority whose capacity and character make them marked individuals and whose prestige gives standing to the entire profession.

It matters little what organized external efforts, so to speak, may be made by engineering organizations or by en-

gineers themselves so long as the general effect on the public made individually or as a whole is commonplace and ordinary, or possibly worse under some circumstances. Efforts to lift the profession by sheer organized force, into a position of high attainments and influence with the public, will have little or no effect. The attack on this problem must be made as in many other cases, at the foundation of what makes the profession, *i.e.*, men with suitable educational training; that training which will not only give them sound, thorough technical preparation, but also the preparation which will make of them cultivated men of broad intelligence, capable of acquiring some learning outside of their narrow technical field so as to give them qualities of character, influence and power in the general affairs of the community. It seems to me clear and simple that in spite of whatever has been said or may be said, that we may learn precisely what we want to know by observing what sort of education has been given to the lawyer and to the medical man and to other professional men. The general principles governing all are the same and it is more than surprising to me after thirty-three years of experience in instruction work and forty-nine years' experience in engineering practice, that there should be any question about such an obvious matter. At any rate the engineers of the country have admitted time after time and proclaimed it to the public that they are not sufficiently recognized nor anywhere near that happy goal after such ordinary educational preparation as they have had. The four-year course of engineering study has served a purpose and served it well but, I believe it may be stated without being effectively controverted that by far the best results have been reached where the course of engineering study has been based upon the broad course of general educational training given by colleges. I know that the usual standard objection will be made that there are few young men in the community who have sufficient time and means to take seven or eight years for such a course of study. In the first place it may be flatly stated that young

candidates for law and medicine find it feasible to devote a sufficient time for the desired purpose and I know of no reason why young candidates for the engineering profession may not do the same thing if they have sufficient virility, resolution and, I hesitate to say, intelligence. In the second place, I can state from personal knowledge and experience that seven or eight years are not required. Six years are ample, three years in the college and three years in the engineering school. If our secondary schools were administered a little more intelligently it would be not only perfectly feasible but easy, as it has been in many cases, to give a young man this six-year engineering course of study and graduate him ready to begin his active practice at twenty-two years of age, which is a less age than that at which many and perhaps a majority of young men graduate from the standard four years' engineering course.

This Society can redeem its past, for in my opinion it sorely needs redemption, by taking up this problem of engineering education in a wise and effective manner, omitting inconsequential and even trivial details which are now too often found in its Bulletins and Annual Reports. In order to justify this criticism I quote a writer in one of the Bulletins of this Society who, referring to the professional school, says "Hence comes the inquiry why it is that current engineering training fails so often to beget a true professional spirit. No generally accepted answer to the question has yet been given." If the writer had been a teacher of engineering he would know that the answer is "that current engineering training" fails to give a true professional education and consequently fails to induce professional ideals and the professional quality.

In speaking of the coordination of universities in order to secure the best results he states that "Such coordination could be applied by a national university, which would function as a center for the development of the professional spirit in the manner just described. Such a national university would give no formal instruction as such. It would

grant no degrees. Its students would be the experts from all other schools, who would be called for short periods to assist in studying national problems . . . ." In other words, there would be a university of universities for practically no purpose except for "short periods to assist in studying national problems . . . ." It is not a wonder that professional engineering schools have not developed effectively along the best lines with such fruitless beating of the educational atmosphere. It is probably unnecessary to state that the writer of these quotations has never had engineering practice or any experience in engineering education.

Again, there may be found in one of the Annual Reports of this Society, a paper on a course in engineering problems as taught at an engineering school, containing a description of the work done, as follows:

"All work was done on standard mechanics paper $8\frac{1}{2}'' \times 11''$. Margins were ruled on the top and each side. The upper margin was ruled into three sections and used for date, name, problem and sheet number. The right margin, about $\frac{3}{4}''$ wide, was used for index headings for the parts of the problem, and the left margin, from $1\frac{1}{2}''$ to $2''$ wide, was used for scratch work or computations. These computations were to be clearly shown so mistakes might be checked. The several parts of the problem were separated by horizontal lines extending entirely across the page and results specially indicated."

It is difficult to understand why such unqualifiedly inconsequential matter should be published in the Annual Reports of any organization designed to promote engineering education. Such a procedure simply magnifies the most valueless details so far as fundamental educational procedures are concerned to an extent that is simply discouraging to anyone who is heartily interested in advancing professional engineering education.

Finally, to make one more quotation only, frcm a Bulletin of the Society, in a recent paper giving the experience of a professor in some school not named, there occurs the following matter:

"I like to have errors in the textbook," said one professor. "I come before the class and this colloquy ensues:

"'Gentlemen, have you gone carefully over the lesson?'

"Silence gives consent.

"'Did any of you have any trouble with it?'

"Usually another silence.

"'Well, did you all verify Equation (blank)?'"

"Equation (blank) is an error, and the professor has them trapped. This may be fine for a class; it encourages thought and shatters a belief in the infallibility of textbooks. But the practising engineer seldom has time to verify equations. He wants to take them as they are written."

When teachers of engineering or practicing engineers indulge in this kind of publication of details, too cheap to be respectable, and when a dignified organization like this Society encourages that sort of thing it is high time that somebody or something should institute a reform. Such cheap details are merely educational piffle.

This Society should abandon all this frittering away of valuable time and effort in discussing to tiresome extremes inconsequential details of educational work resulting in an impenetrable smoke screen of all sorts of educational medlies obscuring the main subject of an effective plan of professional education. Largely of the same kind also are the pages given to the discussion of "Engineering English," especially when introduced into the four-year course. Why an engineer should want anything better or more effective or any more attractive than "good English" is more than I am able to understand. To convey the idea either directly or indirectly that there is some special kind of English which is adapted to engineering use other than the best of good English, in my judgment, is destructive or negative education. If a young man acquires a sound general education, including good English and good literature, I am strongly of the opinion that the discussion of how much or what kind of "Engineering English" he should have either in the four-year course or any other course need not be considered at any great length.

In the case of the four-year course, the student not having had any prior general education at a college or elsewhere, it is probably wise to introduce as much English instruction during the first year as is practicable. A similar observation can properly be made in reference to one prominent modern language such as French or Spanish. Such general culture subjects however should be limited to the first of the four years, and as soon as the required development permits the installation of a prior general education in a college of cultural or liberal arts work these subjects should be confined to that part of the educational training, leaving to the professional school the entire time set apart for technical work. Doubtless in some or even many localities it may be a considerable period of years before it would be feasible to reach the full professional educational training consisting of a broad general education of not less than three years, leading to the professional school having a course not less than three years in length, but that is the end toward which all possible efforts should be directed. College courses taking no more than three years' time are now common. It has been demonstrated over and over again in some of the most prominent colleges in the country, and it has further been demonstrated by actual operations, that in that college course mathematical and scientific studies may be taken to such an extent as to include all similar subjects found in the first year of the best four-year courses, thus completing in a three-year course in the professional school all the educational work now comprised in an engineering course of the highest grade. The complete educational training from college entrance to graduation from the professional school thus covers a period of six years only. Actual administration of such a course has already shown that it is entirely feasible to carry on at any educational establishment of the higher order the four-year course and the six-year course in parallel, so to speak, making it entirely feasible to maintain the full attendance of the four-year course in addition to students who are taking their

educational training on the six-year basis. Naturally in such a case, as many legitimate attractions as are possible should be given to the administration of the six-year course so as to encourage the growth of that part of the professional school to the greatest extent practicable. In such a case it would not be necessary to drop the four-year course until such time in the future as the attendance on the six-year schedule would justify it.

It is no exaggeration to state that the hope of the future of the engineering profession in this country lies in the development of a proper professional engineering education which with exceedingly few exceptions has not yet been attained. There is no field in which this Society could gain prestige or render greater service to the engineering profession and to engineering education than to take formal action in the encouragement of this development. The position of the legal and medical professions point the way with absolute clearness. It is narrow and fatuous to ignore the significance of professional education in these two fields. The general governing principles are the same in all. It is fatal to spend time discussing inconsequential details of this great matter of professional education and ignore the consideration of the broad general principles which lie at the very base of the educational structure. The engineer must be made a man of cultivation as well as of technical excellence. In order that he may become the most useful citizen possible he must combine with his rather narrowing technical excellence, those qualities which give him character and respect of those about him for his executive capacity wherever he is found to possess the executive quality. In other words, he must be a man entitled to receive the confidence of the community in which he practices.

Discussion

President Cooley: I think the Society will agree with me that through Professor Burr I have succeeded in making

my contribution to the program. I wish personally to express my appreciation and thanks to Professor Burr for having put up a sign before us: "Stop, Look and Listen." While I know many things that Professor Burr has stated in his paper will surprise and shock some of our younger members, I am certain that the older members will find themselves in hearty accord with his general statements.

It has been my idea for years that this Society by working along the lines indicated, could make a real impression on the education of the country, and not have its influence limited to engineering. I think that Professor Burr has suggested in the most forceful way the road down which the efforts of this Society should go in the next few years.

While Professor Burr's address is most provocative of discussion I am wondering if it would not be well to defer discussion and let our utterances come later when they will be more matured. For I know perfectly well that certain things to which you will object this moment you will agree with the next moment. I think we had better pass over discussion of Professor Burr's paper at this time.

D. C. Jackson: My ideas on this subject are largely like those of Professor Burr, and are in sympathy with those of Professor Swain but not quite so pessimistic, and no one else having arisen to take advantage of the fifteen minutes I am going to start the thing by pointing out that probably there are many of us teaching details to the minimum advantage of our students and not teaching the fundamental bases of engineering which would be to the great advantage of our students. This is substantially the meaning that I get from Professor Burr's paper. Professor Burr gives a reason, as I understand it, in his paper. I did not hear all of the paper as I was engaged in a committee meeting, but I get from his paper that he states that the reason why we are not covering the fundamentals properly is because we have not appreciated the bases of a professional education. That is a pretty large indictment. I deny that it is wholly correct and consistent, but I am sorry to say that the indictment has a basis of fact, because

we do not always effectually consider the educational aspect of our teaching. The teacher of engineering has a very difficult position to sustain, and it is a more difficult position than will be found in most other branches of education. It exists to a certain degree, similarly in law and medicine. That is, that we must study the problems of education as well as the problems of engineering and must correlate the two in developing professional knowledge and ideals in our students. If we industriously work our methods out with these thoughts in constant mind, Professor Burr's indictment will soon lose force. I wish to make a statement in defense of the Society in view of the implications of Professor Burr's paper this morning. As we sat at lunch today Dean Hughes said to me that in his opinion the Society is no more ineffectual than any college faculty in the United States.

J. A. Randall: I am very sorry that the author of this last paper is not here for I would like to ask him if he has given full consideration to the present state of the educational art? I wonder if he has read John Dewey, for example? I wonder if he is analyzing engineering education with the dynamic definition of knowledge in mind? It seems improbable that one who has read understandingly Dewey's " Reconstruction in Philosophy " would write a paper like the last. It appears to me that an analysis of engineering education, beginning with culture as one primary element and discipline as a second element starts the discussion at a point so far back in educational history that it does not promise to lead us to any valid solutions of pressing engineering educational problems.

I think this Society took a very sound step, when, in cooperation with the Carnegie Foundation it promoted a study of engineering education. That study has been used as a textbook for the younger members of the faculty of most of the institutions represented here. It has furnished an analysis of the engineering educational situation which has helped exeryone who has read it. Yet that study is too brief. It is not a complete analysis. It is but a skeleton analysis upon

more sound educational lines, than the old line of thinking which emphasized culture and discipline.

If this group of people assembled here takes seriously the demands of Professors Burr and Swain that this Society take more effective measures toward improving engineering education, it should undertake to carry forward the study which all agree has been ably started by my chief. He recognizes that there is need for carrying the analysis in his report farther. We can see as we study in the war department the problem of officer training, the need of an analysis more detailed than is recorded either in his Report or in any other publications available.

These analyses presented in the papers read to-day seem to me to be inadequate; they seem to have failed to take into consideration much that is known about the educational art, and I suggest that you seriously consider drawing up some plan

ENGINEERING TEACHING AND PRACTICE.

W. F. M. GOSS,

President, Railway Car Mfg. Assoc., New York City.

Fidelity to the text requires me to confess that I find difficulty in determining the extent to which my earlier views have been modified by more recent experiences. I have the impression that anything that I can say in response to your request must be regarded as an outgrowth of my experiences as a college officer; I have no startling vision of recent origin which I can set before you.

A college course, whatever its trend, is designed primarily to train for leadership. This does not mean that all who complete such a course will achieve leadership, but that where large educational opportunities are offered, exceptional qualifications should result. The privileges of a college course are not ordinary, and those who enjoy them disappoint if they fail to achieve. With respect to training afforded in leadership therefore, a satisfactory course in engineering must take its place, and stand the test, with other recognized college courses.

There are many fields in engineering in which leadership may be exercised; they include scientific research, design and construction, as well as the organization and direction of men. The engineer who advances the art through the quiet processes of his study, may be as much a leader as one who builds an unprecedented structure. The field of activity is not in itself important to the present discussion, the point is that every field presents the possibilities of leadership. The test, therefore, of a course of study in engineering is that it shall tend to develop in men such qualities of character, and such abilities, as will permit and impel them to works of leadership.

It is a matter of common knowledge that courses of study in engineering have generally been the result of a growth process. In their beginning, they have consisted of strong

lines of mathematical work, underlying subjects which from a technical point of view, characterize the course. With these mathematical and technical subjects there have commonly been allotted a certain small measure of so-called general or cultural subjects. As time has passed the science and art of engineering have expanded and the ambitious professor of engineering who has properly desired to have his course keep pace with the development of the art, has been compelled to add new technical subjects. Such additions have for the most part been superimposed upon those previously existing. While it has been thought imperative to add subjects, it has been hard to cast out subjects which have had a secure place in a course, so that the tendency of these changes has on the whole been to intensify the technical character of the course.

My present purpose is to emphasize the fact that the process of course-making to which most of us have been committed, is one which has required us to crowd into the measure a little more than the measure can easily hold. It is at this point that defects appear, some of them serious and very common. To some of these defects I wish briefly to refer.

Engineering courses are not infrequently relatively heavier than other courses in the same institution; that is they require more scheduled time than the liberal art courses in the same or similar institutions; those who are responsible for engineering courses not infrequently express the belief that because their courses are heavier, the fruitage is greater. Is it so? Can it be tested out? Is it the heavy course or the relatively lighter course that has given most in leadership?

I am sure that engineering courses are sometimes too heavy; that the requirements of recitations and lecture rooms, of drafting-rooms, and of laboratories, too often serve to keep the student occupied with allotted tasks. He has little freedom of action, and conditions do not encourage the exercise of choice. He reads but little. His opportunity for viewing broadly the field with which he is occupied

is limited. He is burdened with routine. He works but is not inspired. Such a process makes obedient followers, does it train for leadership?

I have often asked myself whether a part of the crowding of our engineering course may not be due to our persistence in teaching subjects which in fact do not need to be taught at all. It is obvious that texts which are chiefly descriptive need not be taught, that they can more easily be read in the quiet of one's study than acquired through the laborious processes of the class-room. What would happen to our engineering courses if they were made up to include only those things which are most difficult to acquire, leaving out entirely those matters which the student ought to be able to acquire in his own time by himself? He need not be deprived of the inspiration of a teacher in the pursuit of such work, neither need the work appear as a part of an assigned course of study. Progress in this direction would result in manifest advantage. The extent and character of the student's reading would be largely shifted from the professor's shoulders to his own. I do not mean to say that such a change would be free from difficulties; I only urge that the development of such a change to whatever extent it may be possible, could not fail to strengthen the primary purposes of an engineering course, namely, that of training for leadership.

The modern engineering course affords scant opportunity for the inclusion of non-technical subjects. This fact is not necessarily evidence of lack in the quality of the engineering course. No four-year course can include everything. A limit is reached when a proper amount of work is prescribed. If the training afforded by the course is satisfactory, the resulting educational effect will be satisfactory, regardless of whether a specified two- or three-hour course is included or omitted.

The preceding statement leads me to the observation that the specific list of subjects which makes up any course is not a matter of great importance, except insofar as it may

be necessary to establish a desired sequence. The designation of a course determines in large measure the specific facts which are to be utilized for the purposes of the course. The facts themselves, however, are of far less importance than the educational effects of the training. College men who are a few years removed from the day of their graduation, do not ordinarily place any considerable value upon the facts they acquired in college. What they do value is the ability they acquired to find, interpret, and assimilate other facts which the duties of the day require them to have.

It does not follow from the preceding statement that I undervalue the advantages of multiplying engineering courses. The group topics which will satisfy and inspire one student may not appeal to another, and there is a great gain to the college if it can in some measure reflect in its activities, the technical and industrial interests of a broad field. Where many students are to be provided for, there may well be numerous courses. The presence of the many men required to administer a variety of courses broadens the opportunities of students and instructors alike; and greatly increases the power of the college in public service and research. But such advantages should not for a moment be allowed to obscure the fact that a multiplicity of courses, or the multiplicity of subjects in the make-up of an individual course, are in no wise necessary to the satisfactory training of students in engineering to a service of leadership.

Finally, I venture to note that in this great country of ours, the school or college of engineering, as an institution dependent upon human agencies for its development, must necessarily be influenced by the spirit and progress of the times. The past forty years have brought great changes into the life and the economies of our nation. Organization and machinery have been important factors in the development of these changes. It is perhaps reasonable to assume that in a community where organization counts for so much in other relations, it may also be relied upon in the development of educational resources and processes. But if we

are inclined to build and organize colleges in much the same way and with much the same spirit that we build and organize industries, we shall fail, for the laboratory is not the college, and a faculty cannot be produced on demand. The great need of the school of engineering today is not more subjects, nor more courses, nor more years to devote to training, but more of the spirit of the cloister in the relations which characterize intercourse between student and instructor. In former days the student attracted by the reputation of a great teacher, not infrequently traveled long distances and suffered many hardships, that he might hear the voice of the sage whose instruction he sought. When the spirit of the student and the sage pervades the modern college of engineering, the whole subject of curricula, relatively speaking, will greatly diminish in importance.

The first generation of our country's teachers of engineering has now passed. The rich heritage which we the present generation of teachers possess, is of their giving. The extent of their achievements is measured by the wealth of our possession. There is imposed upon us the duty of so exercising our leadership, that we as well as they may achieve for the generation which will succeed our own. Let us be diligent in our efforts to improve our engineering curricula!

I regret, Mr. President, that my contribution to the important topic you have assigned me, is necessarily so brief and so feeble.

SOME RESULTS OF THE COÖPERATIVE SYSTEM.

BY JOHN W. HALLOCK,
Director of Coöperative Work, University of Pittsburgh.

In studying the results of any undertaking, the measure of success of such results is the degree to which they approximate the aims and objects of the undertaking. In considering, therefore, a few of the results of our Coöperative Plan of Engineering Education at the University of Pittsburgh, it may be well to outline first the objects which its originators had in mind at the time of its inception more than ten years ago.

These aims may be said to be four-fold. There is first the object of placing the student where he may come into intimate contact with all classes of skilled and unskilled labor, where he may observe methods of handling groups of such men for the advancement of a given industrial enterprise,—where, in short, he may, with proper guidance and supervision, appreciate the application of the humanities in our present scheme of production. There is second the object of assisting each student by a study of the various industries with which he comes in contact toward the selection of that industry for which he shows the greatest aptitude. There is third the aim of acquainting the student with the application of some of the fundamental processes of manufacture and the coordination of these processes with the theory as taught in the classroom. Lastly, there is the aim of developing, by a combination of the three other objects listed, men capable of assuming executive positions in industry. These are the four ends which we are striving to attain in our coöperative plan at Pittsburgh.

Now in considering any *results* of our plan, we must consider the three parties who are certain to be affected by its

application. These are the student, the institution and the coöperating industries. Let us take up these three parties and apply to them the four-fold rule of our aims. And in this consideration we will omit all reference to the details of operation of our plan. Such details necessarily vary in different localities and with different industries. They do not seriously affect the results to be expected and are therefore out of place here. Let us consider these parties in the reverse order and take up the coöperating industries first.

With respect to their views on such a plan of coöperation as we have at Pittsburgh there are probably two outstanding views held by executives. First there are those who say, "Teach theory only and make the courses very general. Leave the practical side to be taught after the men enter the industry." The number of men holding this view is fortunately growing smaller almost daily. Second we have the ever-increasing number of executives who claim that the addition of all the practical work it is possible for a student to get makes him more valuable to any industry he may later enter. We meet men of both these groups in our coöperative work at Pitt and yet with but one exception we have never failed to establish coöperative relations with all groups alike.

Having established coöperative relations with these industries, we are sometimes surprised ourselves at the attitudes which these executives soon hold with respect to our plan and the school. At a recent meeting of executives of coöperating industries some startling statements were made illustrating these changes of attitude. Mr. J. G. Chalfant, County Engineer of Allegheny County, said, "When this plan was first put into operation we were glad to coöperate because we thought the county might thereby help the institution and some of its students. I am frank to say, however, that I believe the county has benefited as much as the students or the institution." Mr. F. R. Phillips, Superintendent of Equipment of the Pittsburgh Railways Company,

said, "The greatest step forward in the electrical railway industry in this district was the inception of the Coöperative Plan with the curriculum of the University of Pittsburgh."

So much for the executives in coöperating industries and the results secured with them. Now what is the effect on the worker in the shop? Here we have at the start all attitudes from that of the man who delights in helping the student worker to the sulker who feels that he cannot afford to give help to this man who may some day become his boss. These differences of attitude are good for the average student. They prick his self-conceit and improve his perspective. The weak-kneed student is forced to buck up and work and seek information for he is constantly under the supervision of an instructor from the University and is thus always "between the devil and the deep blue sea." On the whole, however, the students react well to the environment and associations in the shop and in the field. In many cases extremely cordial relations have been established between workmen and students and the time is almost certain to come when this common understanding will prove of mutual benefit to all concerned. In one shop, for instance, a student organized a small class in shop mathematics. He showed his fellow-workmen how to find the areas of various geometric figures, how to perform many of the fundamental calculations of arithmetic and algebra, how to read blue prints, etc. The blackboard was a convenient casting, the time of meeting was the lunch hour and the tuition was a fruitful exchange of ideas and pointers on the work of the shop. It happens that in the particular plant referred to, this little class resulted in the organization by the company of a regular educational department, the work of which will some day so hold together the men of the shops and tie them to the company that labor troubles which in the past have been a great annoyance and loss will be greatly reduced. This is only one example of its kind. Many others might

be given to show the wonderfully beneficial and far-reaching results which may be attained by students' associations with shop men.

Perhaps the most direct as well as the most important effect of the coöperative plan as reflected in the coöperating firms is the eagerness with which graduates under the plan are absorbed by industry. This year—a good year in which to judge if there ever was one—one hundred per cent. of our graduating class were in receipt of clearly defined offers for their services. Many of them had several offers from which to choose. Surely this is a tribute to the success of the plan.

The second party to be affected by the plan is the faculty. These students come from the shop into the classroom full of practical ideas and of familiarity with the most up-to-date methods of doing things. It is only a natural reaction, therefore, that the members of the faculty are kept constantly on the alert to keep abreast of latest practice and to incorporate such data in their courses. A student who has assisted in the work of boiler assembly can hardly sit back and be silent if the instructor outlines boiler shop practice which was in vogue ten years ago. And here again the great diversity of industries in the Pittsburgh district gives the instructor his material as well as the student his laboratory.

(I do not mean to imply by these last statements that we have a faculty the members of which are in sympathy with the coöperative plan only through force of circumstances. It can be truthfully said that our faculty, perhaps because of outside consulting relations already established and a consequent realization of the great value of. practice with study of theory, have been the real cause of any success which the plan may have attained.)

It is without doubt—and properly, too—the third of the parties affected by the coöperative plan of engineering education which proves the most interesting from the standpoint of results. From the time a student matriculates, he is made the subject of careful individual study by an in-

structor in the Coöperative Department. Records are obtained and carefully kept up to date of each student's earlier industrial experience, his preparatory school work, his attitude toward the profession of engineering. In short, we are trying always to find each student's personal viewpoint and perspective. During the first year we are frequently able to accomplish a great deal toward improving the perspective, stimulating the interest and elevating the aims of individual students. Much of this is accomplished through the contact of these students with the heads of the various departments. A course known as "General Engineering" has been given this past year to freshmen. This is a general survey of the work of the engineer in all branches of the profession. Its value, aside from the instruction, lies in the opportunity for the student to adjust his viewpoint, but just as important are the helpful observations of the heads of the departments in listing the personal qualities and aptitudes of members of the class.

When a student is ready for his first assignment of three months to coöperative work, we have an accumulated mass of information which makes his assignment almost as easy as the sorting of type dies in a linotype machine. Even after the first assignment is made, this study of individuals is kept up. Students known to be weak along the line of certain personal qualities are given particular attention and are encouraged to strengthen such weak points. In this we have been especially fortunate in securing the coöperation and assistance of executives in industry. At the close of each term of coöperative work, one or more of these executives rate each student on five points; namely, ability, industry, tact, reliability and initiative. It is surprising to note the marked improvement in the cases of certain students who are rated low on any of these qualities during early terms of coöperative work. This is due in large part to the fact that each student knows he will be rated on these five points and therefore makes strenuous efforts to secure a good rating by employing firms.

From these facts it will be noted that our plan fosters not so much the acquiring of the knowledge of the trained technician as the development of the traits and qualifications of executives. It is a significant fact that of the entire number of men graduated since the inauguration of the plan ten years ago, more than thirty per cent. now occupy executive positions in industries with which they engaged in coöperative work. Of the remainder about a similar percentage occupy executive positions in other industries, employment in which has been made possible by earlier coöperative training. But perhaps the most significant result of all from the student standpoint, and indicative of the soundness of the training given Pitt engineering students along the line of executive work is the leadership which very largely falls to the hands of these students in all undergraduate activities from athletic teams to musical clubs. And lest it may be said that the later success of such students is the result of the *natural* qualities of leadership they possess, let it be added that a canvass of alumni disclosed the fact that fully ninety per cent. of such men ascribed no small degree of their success to their supervised work in the industries.

One rather general sidelight on our coöperative plan, and one on which I had hoped to have sufficient data to present at this meeting, is the matter of incomes received by graduates since the inception of the plan as compared with the incomes of graduates prior to that time or as compared with the incomes of graduates of other institutions not offering this supervised experience as a part of their course. If it is ever possible to successfully complete such a study, it is confidently felt that beneficial results could be shown. As the work involved in the compilation of reliable data is so enormous, and as such a study should be more general than a single geographical center will yield, it is suggested that such a study covering a wide field and with proper coördination of results with existing curricula might well be made the subject for extensive research by this society.

There have been presented here some rather kaleidoscopic views of the results of our four-aim plan of coöperative training as regards the student, the institution and coöperating firms. If these seem rather highly colored, the blame should not be laid to either the kaleidoscope or its operator. The colors are true to nature and are made possible by the constant encouragement and coöperation of our dean and the heads of our departments. It is hoped that a free and frank criticism of our plan and the observations herein made of it will result in a still broader and more successful application of it.

DISCUSSION.

W. H. Timbie: I would like to call your attention to the way in which this paper links up with the papers this morning. The discussion this morning was upon the subject of broadening the foundation of the student's education to such an extent that he might take in more of the general studies and at the same time get the necessary technical subjects.

This generally means six or seven years of work in school which often renders a man out of touch with the industry and is likely to make a sort of bookworm out of him.

By this coöperative scheme a man can spend three years in one of the old line institutions of learning, get two years credit for it at Pittsburgh, M. I. T., or some other engineering school. He will then spend three years there on the coöperative course, acquiring his technical work, his broad foundations, his scientific studies, and at the same time keeping so closely in touch with the industry that when he gets through, although he will have spent six or seven years in school, of these he will have acquired from five to six years school training and the equivalent of from three to five years of practical training which has not been supervised. We feel that three and one half years of supervised practical training is equivalent to three or five years of unsupervised. A man therefore has really made a gain in time, so that when he comes out from one of these courses even after spending six or seven

years in school, he is much in the same position as far as the industry is concerned as the man who has spent four years in school and three years in the industry,—but he has all the additional advantages of a general college course, a technical training and often a higher college degree.

A. M. Wilson: There is one feature of the coöperative plan that I know Professor Hallock must have had in mind but which he did not touch upon. I would like to refer to the by-product of the courses, to those who do not succeed. We have quite a few, of course, who start and do not finish.

In their coöperative training they have a real asset. Some young men desire to pursue engineering, they think, but they do not have college caliber. They go as far as they can and if they have not had practical training along with their college work they often drop out with a sense of failure.

We find that a great many of these young men who cannot complete the coöperative course, step into industry fitted for the kind of work they can do; and the training they have had in connection with their college studies, has been of real commercial value to them, besides giving them that broadening influence which all real honest education is bound to give.

W. S. Franklin: I have just one thing more to say, and that is this—I have listened to discussion of education for leadership until I am sick, and I would like to propose that the most important element in education for leadership is to furnish a man with some followers. This idea of herding all of the highbrows into one super-institution and training them for leadership is pure humbug in my opinion. I have been wildly enthusiastic about this coöperative scheme since 1898, and I believe it is the only kind of education for leadership.

Mr. Hughes: I just want to add a word; one year ago we adopted this industrial coöperation in a limited way at Harvard, as compared with the time devoted to such work at Cincinnati and Pittsburgh. We have had but one year of experience; as far as that year goes it has confirmed our faculty in its belief in feasibility, and in the merits of the scheme.

We have found many difficulties, and we expect to find more; but on the whole the plan has worked successfully. We have had in a limited time the same kind of results as Pittsburgh and Cincinnati have had in their larger and longer experience.

D. C. Jackson: It would seem from the description which has been given of the coöperative plan in this interesting paper, that is works very easily. The fact is it was not done in that easy way, but it was really a rather difficult job when Dean Schneider worked out his plan and had it put into effect in Cincinnati. It was worked out with a great deal of care and thought. He had worked upon it mentally for years. He studied the subject from the standpoint of education. He also studied it from the standpoint of the industry, *per se,* and in its effect upon the educational institutions. He had to meet the skepticism of the industries; he had to meet the skepticism of the teachers who are now preaching the doctrine. I remember that he found difficulty in securing an opportunity to present a paper on the subject before one of our four national engineering societies because the board of directors of the society at that time did not believe that such a matter could be serviceable in education.

Dean Schneider has proved the worth of the idea, and it also has been abundantly proved elsewhere, when judiciously carried out. But anyone who goes into this idea, thinking it is easy, is on the road to sacrificing the educational influence, as it requires a large amount of effort to maintain side by side the work in the workshops and the work of a highly and truly scientific character. It is possible to do it and when it is done I am satisfied we obtain the finest and most desirable education for men who are going into manufacturing industries which can be produced, and from students who follow such a plan will come the great manufacturing leaders of the United States, and that means, perhaps, of the world. But do not let us fool ourselves into believing we can handle this problem lightly.

STUDENT GOVERNMENT AND THE HONOR SYSTEM.

BY PARKER H. DAGGETT,
Professor of Electrical Engineering, University of North Carolina.

The so-called honor system in American Colleges and Universities is of no recent origin. Yet our educational literature is almost wholly lacking in any comprehensive treatment of this subject.

As practiced in most colleges the honor system is but a fragmentary part of one of two possible systems of student government. One is a government of externally imposed rules and regulations; the other a self-perpetuating government of common consent, based upon the principle that "true sovereignty is within the individual man, or nowhere." One is a government of external discipline and restraint; the other a government of vitalized self-discipline that seeks to grow men of wholesome self-reliance who can appreciate the full meaning of Emerson's words, "Trust thyself: every heart vibrates to that iron string."

It is not the purpose of this paper to discuss the pros and cons of these two systems of student government. We shall find scriptural authority for both in the fifth chapter of the gospel according to St. Matthew. And if the supreme test be whether or not it works, we need not look far to find both splendid and shocking examples of each system. Each system has its strong proponents as well as its impatient opponents. Each system succeeds with success and fails with failure to understand its deeper motives.

It is rather the purpose of this paper briefly to describe the organization and some of the accomplishments of student self-government at the University of North Carolina. The roots of the present system may be traced to the foundation

of the University itself in 1795. At that time all students were required to join one of the two Literary Societies. The unwritten code of the student body of to-day is but the outgrowth of the self-imposed system of discipline adopted by the students in these societies over a century ago. And this century of tradition behind the system accounts in no small measure for its success.

For many years the system was administered by classes, each one having its Class Council to which all students were honor bound to report any offence. Later, when compulsory membership in the Societies was abolished, it was found necessary to reorganize, and to a single Student Council were given over all matters of discipline initiated by the students.

Within the last ten years there has grown up alongside of this disciplinary council what was originally called the Greater Council. This body, which is now known as the Campus Cabinet, is essentially constructive in its function. Since it is almost entirely separate and distinct, in its personnel, from the Student Council it can work with perfect freedom towards constructive ends.

The organization and functions of this double-headed system of student government as it now exists at Carolina is explained in the following statements from the University Catalog.

"The Student Council is composed of eight members as follows: the presidents of the three upper academic classes, one representative from each of the three professional schools, one representative chosen by student body at large from the rising Senior Class who is President of the Student Body and Chairman of the Council. These seven members elect the eight men who must be chosen from among those who have served on the Council before. The President of the Junior Class is *ex officio* Secretary of the Council.

"Student government, in so far as it is disciplinary, is based upon the honor system. No code of rules is laid down to direct a student what to do and what not to do. The only

standards are those of morality and gentlemanly conduct. The Student Council is the head of the honor system. It is the concrete expression of the moral University. Its members being elected of the students by the students, it is grounded upon, and gives expression to, student sentiment. The Council is not an organization of policemen, nor is it based upon a system of espionage. When any student is felt by his fellow students to be unworthy to remain in the University, the Council takes cognizance of this feeling. It examines the matter, finds the facts in the case, and decides upon the course to be pursued. If the student is found guilty of conduct unworthy of a University man, he is promptly required to withdraw from the University. Among the offences demanding withdrawal may be mentioned drunkenness, cheating on examination, and gambling.

"The Campus Cabinet is an organization composed of representative students selected by the President of the Senior Class. These representative students are chosen from the four academic classes, the Law, Medical, Pharmacy and Graduate Schools, and the Young Men's Christian Association. The object of this organization is to study campus conditions and campus problems and to relate them to the 'greater University.' It attempts to work out all problems the solution of which would make the life of the students more wholesome and more enjoyable. It is not an executive body mainly, but a suggestive body. It takes up such questions as the social life of the students, the athletic situation as it concerns the whole student body, dormitory improvements, and many other things that it thinks will benefit the students."

Entirely independent of the Student Council, the faculty still exercises some disciplinary power through its executive committee. Practically the only cases that this committee has to handle are cases of cheating, the evidence of which is discovered by members of the faculty. This evidence comes directly from examination books since the students are usually left entirely to themselves during an examination.

The honor system at the University of North Carolina is thus more than a makeshift system of punitive discipline. It is more than an organized effort to prevent cheating on examinations. Indeed, in the spirit in which it is conceived and administered, it is none of these things. Instead of punitive discipline of rules and regulations, imposed on the student body by faculty mandate, there is the single supreme standard—Carolina students should act like gentlemen. Such a simple standard is not difficult to understand; it is not difficult to attain; nor is it easy even for the most abnormal student to break it.

The reasons for our faith in this system of student self-government are, first of all, our faith in the students themselves. The late President Graham, in addressing the student body at the usual mass meeting on the opening of college in 1917, expressed it in the following words: "The faith for which the world is now being tested out in a crucible of fire is the faith that with the right to live freely, men will live rightly; that with a free choice between the inferior and the superior, free men will always choose the better way; and that knowledge and power to choose rightly in any activity, and the continued purpose to carry out the choice, come from within." It is this faith in the essential goodness of man that is the indispensible foundation of our modern business structure. It is this same faith that we openly profess to have in our students. And our experience shows that the trust has not been misplaced, for throughout the long roll of years it has never been violated.

In the second place we take it to be the supreme duty of a state university to strive to the utmost to furnish men of sound character for the future leadership of the democracy that gives it birth. Everyone knows that physical and mental powers grow by use. Is it too much to expect that moral and spiritual powers will do likewise? The byword of the day, "learn by doing," is just as apposite when applied to a young man's moral development as it is to his mental. To para-

phrase ex-president Wilson, the trustworthiness of students trusted must inevitably grow with the trust.

Thirdly, our faith in the system is based on its achievements. Here are some of the cases on what has aptly been called "the casualty roll of honor." Last year two students, one guilty of cheating and the other of passing worthless checks, were summoned by the Council. They voluntarily withdrew rather than face the charge. Another student cheated on examination. No one discovered him. But the secret of his own dishonor so preyed on his mind that he went to the President of the Y. M. C. A., confessed and left college.

At various times individuals and groups of students acting together have caused the withdrawal of guilty students without any recourse to the Student Council. Undoubtedly there have been times when some of the older students have acted as self-appointed probation officers. A conspicuous case of this sort occurred only recently. An upper-classman was taking an examination in a course in history. He observed that two freshman sitting on the front row were cheating. After waiting until there could be no possible question about it, he walked over to the two men, took their examination books from them and deliberately tore them up, and then, before the whole class, gave them such a dressing down as in my opinion is likely to hold these two young men in the straight and narrow path for the rest of their days.

I have cited the last case in order to show the sort of spirit that this system fosters and grows in the older men, and because it is the type of case that gives us most trouble. Practically all of the cases of cheating occur during the first year of a student's residence within this miniature state. And it is with this class of men only that we are lenient. First year men, convicted of cheating, are given a chance to come back, because it is recognized that it takes time to make the transition from an atmosphere of untrusted supervision into one of self-disciplined freedom.

The above cases are of course exceptional. The ordinary cases, and there were only eleven of all kinds before the Coun-

cil last year, are reported to the Council for investigation by the students themselves. And under the system this is not preaching or tale-bearing, nor is it so considered by the students. And one of them, writing in the college newspaper, puts it, "If a man is a gentleman he will not tolerate things ungentlemanly in others. In other words if he sees a man cheat or gamble he will report him to the proper authority without hesitation."

Perhaps at no time are the fruits of this system so evident as at times when the opportunity for mass action occurs. During a championship baseball game a batter interfered with the visiting catcher who attempted to catch a man at second. After the game the students held a mass meeting and discussed the case. As a result an apology was sent to the opponents with an offer to throw out the game and play it over.

One point I want to emphasize about the system of student government at Carolina. As it exists today it is the result of a gradual evolution requiring more than a century to reach its present form. During this time it has acquired traditions which have carried it ever onward to greater achievements. And these traditions have helped also to carry it over the rough places. Once a student appealed from a verdict of the Council. The appeal was to the executive committee of the faculty which reversed the decision of the Council. Whereupon the whole Council resigned. The situation was serious. Open rebellion was imminent because a decision of a committee elected of the students and by the students had been reversed by a power in the choosing of which they had no voice. The matter was adjusted by a final appeal to a committee of the faculty elected by the students. This committee sustained the action of the executive committee and the students were entirely satisfied. This took place some ten years ago and since then there has never been an appeal from a verdict of the Council. If there ever should be it would undoubtedly be handled by a committee elected as this one was by the students.

In conclusion, from my observation of student self-government during the past eleven years, I have no hesitation in declaring my entire faith in it. I know that it has been truly, though impatiently said, "Oh, we have tried the honor system and it wouldn't work." I know that it has failed in some places, but in practically every case, failure has been due to one of two impossible conditions. When the honor system is planted in a single department or division of an institution, the best that can be hoped for it is only partial success, because of the double standard created. When student government is adopted in its entirety by the whole institution it must be given time to take root in its own traditions. If one group in the faculty impatiently insists on treating it as a weed, to be uprooted after the first storm, no amount of cultivation and nourishment supplied by those who have faith in it as a flower of truth, goodness and beauty, will be of any avail.

It is a difficult thing to establish student self-government in any institution. It is, possibly, quite impossible to establish it in a large one—and it certainly can't be established there over night. It is highly undesirable to attempt it in any military establishment.

Student self-government is an ideal system, a system of ideals. It *will* work. And when it does, it can be counted on to grow strong men, men of self-reliance, men of character.

THOUGHTS ON ENGINEERING EDUCATION.

BY RUDOLPH HERING.

Within the few minutes available for discussing so large and important a subject, it is possible to give only the barest outline to a few thoughts. But I shall endeavor to give them some definite and consistent form, based on the experience of my own long and active professional life.

The noblest and most valuable of all occupations is the education of the young generation of the human race, for the purpose of taking an active part in its development, and of raising its members to the summit of a modern community.

The pursuit of an education along progressive lines with the closest practicable adjustment of individuals to their social environment, confronts us with a complex problem with which the world has struggled from the age of the Greeks to the present day. Much has been gained, but a complete and final practical victory seems still far off. Yet education now appears at least to be coming into its own as a science, through the gradual acquisition of accurate knowledge of principles and facts accumulated by long experience.

Every man through his inborn capacities and natural energy, has his own place and job in the world. Therefore educational authorities must segregate the young individuals according to their best capacities, so that the combined available human energy can be utilized to its utmost and reach its practicable maximum.

Successful and progressive education depends on four conditions: one, interest; two, discipline; three, responsibility and self-reliance; and four, opportunities to transmute knowledge into action.

Of these conditions the first one is frequently undervalued. Interest, rising to fascination or even inspiration in the acquisition of knowledge, is the prime requirement for receiving and retaining information. Without interest real learning and the most effective work is impossible. To create it we must have opportunities to unite cause and effect, to see inevitable consequences and to follow a subject understandingly at every step from beginning to a legitimate end. To heighten it the process of acquisition must arouse emotion and harmonize with our temperament. When a large percentage of the students do not assimilate or have no interest in what has been presented to them, does this not indicate some error in the method of presentation, rather than incapacity or indolence of the student? Progressive education should endeavor to interest the student just as a business man finds it necessary to interest the public in what he has to sell.

In addition to the proper method of teaching, we should consider also the receptive condition of the student. The morning hours are best devoted to those studies that require the greatest mental energy, the afternoon to those requiring more observation and physical exertion than mental work, such as subjects of natural science, history, drawing and geography, and the evening to leisure or pleasing exertion or recreation. All necessary rest is best obtained when asleep. Home study, unless it is confined to the early morning hours, should in the evening when the mind is most tired be minimized and confined to light reading and easy work, such as arts, music, reviewing notes, reading to supplement the school lectures, and to mechanical work. Study hours during the day at school are much better. Now and then there has been an effort made to abandon home study and correspondingly increase school hours. In some instances it has succeeded, in others not. The reason must probably be sought in the different methods of teaching, because the children in the different cities of our civilized countries are very much alike.

The most vigorous impressions upon the mind are received through the senses. Real objects should be presented in their natural condition, or with the aid of moving pictures or scenarios, so far as practicable, instead of by verbal or book descriptions. What cannot be shown within the school room should be done where practicable by an outside visit to the natural objects themselves.

Is it better to let the student wrestle with new problems, as often done, than to have all the salient features first explained to him? Every student cannot find a new method of solving problems. He can surely profit more by first acquiring a thorough familiarity with the generally known solutions, and then attack new problems simply by varying the applications. Many students have in that way lost interest and have even acquired a disgust for the subjects, if the planes of ascent have been made too steep for them to climb with reasonable comfort and satisfaction.

The occasional hard grinding with the aid of artifical book learning, impelled by the "push system," should be supplanted by a more natural study, which we might call a "pull system," the original meaning of the word "education," derived from the Latin *e* meaning "out" and *duco* "to lead or to draw." The pulling force of the teacher should first be directed to arouse an interest, which automatically opens the student's mental door, and then for an easy reception to place before him all the facts and principles which he should reconcile in his own mind.

While it may help some to refer to textbooks, and they should be available, it is much more effective to be taught orally by the teacher's own live words, than by silent textbooks. The latter, almost like dictionaries, have their use, but they cannot supplant the advantage of conversational teaching any more than one can learn to speak a language fluently from a grammar and a dictionary.

The second condition, discipline, should be taught and acquired for the purpose of accustoming us to the inevitableness of law. Through order and regularity we can ac-

complish specific results with the least effort. It brings concentration, courage, character and confidence and through truthfulness, honesty, courtesy of speech and manner, we accomplish most with our fellow men.

The third condition, responsibility, is a training which produces reliability, one of our best and most valuable qualities.

The fourth condition relates to the ways and means through which our knowledge enables us to accomplish results.

To restate the above-mentioned conditions with other words, an engineer, to be a successful citizen, must have an education and training, first, as a cultured human being and member of the social organism of which he is a part, and secondly, as a student and future practitioner in the profession selected by him for obtaining the necessaries of life—a profession, perhaps the loftiest of all, as it utilizes all of the known forces of nature for the benefit of that organism and of all its parts. For this purpose he must acquire much and varied knowledge and a long line of experiences. His education, according to Spencer, will then secure to him "a complete living."

Let us first consider the engineer as an individual and a member of a social organism. As such, his most important duty is self-preservation. He must have good health, and a physical and mental development, sufficient to successfully face the world with all of its ordeals. He must secure the means of livelihood for himself and family, and educate his offspring to take his place in the next generation.

He must acquire knowledge of many of the concrete sciences and of their applications; of which the most important for all individuals are physics and chemistry, because they continuously affect most of our daily activities, in order to live a healthy, comfortable, intelligent and happy life. He must train his body to resist evil forces and to benefit from helpful forces. He must train his senses to receive impressions quickly and correctly, and his hands for writing, draw-

ing and many other uses so that they become his most valuable tools.

He must acquire also a knowledge of and training in the ready use of the two abstract sciences, logic and mathematics, to regulate and strengthen his reasoning powers. A single error in the application of either would cause failures of conclusions, of organizations and even the loss of life. Mere knowledge of facts without their true relationship is of little value. Therefore, the mental powers are an essential element. Correct habits of thinking and classification, when applied to close observations, help us to analyze correctly, to weigh evidence carefully and to arrive at conclusions which produce reliable results.

As members of the social organism we should acquire the efficient use of the languages of the country in which we live, by which our thoughts are formulated, compared, classified and sifted, so that they clearly express our conclusions to others and build up the mental power of the community.

As citizens we should be acquainted with the present condition of the world, of its inhabitants, the efficiencies of the different nations, their social lives and customs. In order to understand these present conditions of the civilized world we should know also the history of civilization from the earliest time to the present, then we may clearly recognize the directions of hopeful, retarding and disastrous developments of different countries at different times, and the rate of speed at which they have taken place and which will probably be a guide in controlling our own future progress.

Finally, we should acquire sufficient knowledge and training, so far as practicable, to enter into the general social enjoyments of the community in which we live, and therefore cultivate our esthetic tastes and feelings, to comprehend the higher arts of leisure and recreation which civilization has developed.

A word should yet be added regarding examinations. Many if not most of the scholars fear examination. It has occasionally happened, again two weeks ago in Newark,

N. J., that a scholar committed suicide just before examination.

I have read through many examination papers with my five children and doubt if I could have answered more than one half of the questions. Such examinations do not always reveal the real knowledge and capacities of those examined. It seems to me that the custom prevailing in some schools, of having small classes and a more intimate personal intercourse with the teacher, with weekly or monthly repetitoria would much better fulfill the intended objects of the semi-annual examinations.

Let us now, secondly, consider the engineer as a student and embryonic practitioner in his chosen profession. His education should acquaint him both with the theories which apply to his intended work and with the practices by which they are executed. His work is the application of the known forces of nature to advance our personal and social progress, and to prevent its regressions by destruction, failures and discomforts. Therefore, his professional education must be thoroughly scientific in its foundation and method. It must lead to an understanding of the known laws of nature and of their relation to each other.

Such knowledge, incidentally, when derived from the utilization of natural laws, leads the engineer to think along similar lines also in other matters, *i.e.*, to always think logically and mathematically, directly and straight, in the endeavor to reach reliable results.

The teaching of theory and practice should go hand in hand. Effective engineering education cannot be theoretical or rational alone. It must be intimately connected and co-operate with experience and application in practice. Separated, each one loses its greatest strength. To save wasted time no theories should be developed at length in college, which have no useful application in early practice, and which can be as readily acquired later in life, when their practical usefulness to the student may naturally develop. Nor should our limited time in youth be devoted to more

practical applications and work, than to fully understand and appreciate the theories which will be taught before graduation.

This coöperation has been recognized in our country since about 50 years ago by the establishment of manual training schools in the lower grades of teaching. Its necessity was recognized in some parts of Europe almost a hundred years ago and practiced in the higher technical schools.

Colleges and universities should devote their time, first to theory, for which they are eminently fitted, and secondly, to the direct application of fundamental principles to the basic and most simple practical operations and problems, to the initial steps of research work and creative design. Sufficient time and practise should therefore be given during the courses to the attendance of work shops, to making surveys and inspecting the building of structures, so that the student will at once understand and appreciate the help from theories which he has learned or will still be taught.

Nothing arouses the true interest in acquiring proficiency more than this intimate coöperation of theory and practice. As the student's true interest is the main-spring of his accomplishments, such coöperation therefore tends to raise him to the top of his abilities.

Mechanical, electrical and chemical students should be connected with suitable industrial establishments in some capacity, so as to be better able to unite theory with practice. Dean Herman Schneider of Cincinnati first organized in this country a coöperative engineering course for mechanical engineers, which was a long step in advance. Pittsburgh followed. Similar coöperation should be applied also to other branches of engineering. Civil engineers should have practical courses—one day per week and about two months in the summer for surveying and visits of works under construction. Even several days at a time might be profitably devoted to a single structure, such as a large bridge, at a time when some important part was being built. Such practices already prevail in some of the best colleges.

In Europe, as well as occasionally here, the total time for college education is about eleven months per year, leaving therefore one month for vacation, or generally more than is customary to get after leaving college. If the college studies could be pursued with as much interest as a small child exhibits, when it first meets with new sensations of sight and hearing, the student would have no regret to increase his learning time.

Prior to learning the theories which enable us to design works, it is essential to thoroughly know all the qualities of the various materials used in construction. Designing work at college had best be limited to elementary structures, so as to familiarize the student with the fundamental principles of design, when using the different materials available. It seems a waste of time for a student to design one large and complex structure, taking perhaps a full semester, which he may never be called upon himself to design, instead of designing a large number of different structures but only in outline, and a large number of the many essential details in full.

We have but comparatively few years to acquire our education and it would seem important, in view of the continually increasing demands upon engineers, to arrange our study plan and training so that we omit the lesser essential studies and let the others follow in the most effective order of time. Each subject should be commenced as early as the mind can follow and readily grasp it. Languages are learned best for good reasons when the child is quite young. So also many physical accomplishments and the lowest forms of reasoning and of mathematics. Where higher reasoning powers are required, the subjects should be taught only after they can be assimilated with ease and pleasure and not before. Among the more difficult subjects to be taught which now call loudly for preparatory education among engineers, are those which relate to social questions with which they are becoming more and more intimately connected.

Although not always a producer, the engineer is yet one who knows best how production is accomplished and who realizes, with his mechanical formulæ, that idleness, competition and duplication of effort are waste.

The engineer is also often required to prepare evidence relating to the financing of large projects, to labor problems and even to governmental affairs.

These social problems are being recognized as also resting upon natural laws, and their technical application to such problems requires the aid of an expert having a knowledge of both classes of law. This leads to a further increase of study for the engineer. He must learn the fundamentals of an efficient organization, resting on fair play, initiation and coöperation. To accomplish this, he must become a good executive, who must be responsible for the results of a newly created and finished product and its operation. Colleges and universities are therefore being called upon to teach their engineering students the fundamental principles also of industrial management.

The professional activities of engineering are spreading over an ever-enlarging field. Increasing knowledge of the laws of nature, of which our ancestor, Leonardo da Vinci, the first engineer, said: "Nature never breaks her own laws," causes engineers to live all the time up to their best capacity, physically, intellectually, ethically and creatively. Engineering education therefore promises to be conducted in the future as one of the most interesting professions, and for our civilization one of the most valuable pursuits.

SYMPOSIUM ON TRAINING OF ENGINEERING TEACHERS.

G. C. Anthony: Mr. President and gentlemen: this is a subject with which I would like to deal had I a little preparation, but I am pleased to say something without any preparation, because it is the most vital thing we have to consider—in fact that this Society has to consider.

I think that we older ones surely recognize the difficulty of doing the real work of teaching under the present conditions—the embarrassments, financial and otherwise; the inability to hold the men we ought to be able to hold; and also the inability to do effective work in the training of these men during the processes of conducting our work in our respective institutions. I know that I am guilty of a very haphazard method in assisting in the training of the young teachers. I have wanted to do things very differently from what I have been able to do.

Now, inasmuch as I have not even read the report I may shoot a little far from the mark, but I do want to diverge a little as my mind goes back to the session of yesterday and its relation to liberal arts schools, especially the teaching of English. That is a department in which I have been very much interested in the matter of training teachers, and wherein I have found it to be absolutely necessary that it shall be done in the technical schools. We have not been able to efficiently use teachers who know nothing of the characteristics of the engineering student and that is the root of the whole trouble referred to by the speaker of yesterday. We all know we are not teaching a special English in an engineering school, but we are teaching English to engineers. That is perhaps the most important part of our work.

Just a word more concerning that: I think there are two classes of teachers, (1) those who have been in service a very

short time, who are so close to the details of the profession that it is impossible for them to get a proper perspective and a broad view. And (2), yesterday it occurred to me that some of us might be getting so far along and having such a very great perspective, that we are losing sight of important details. This a comment which I think might apply to the training of teachers, and other matters with respect to this Society such as the *Bulletin,* and the work of the committees.

As regards the teacher of today, personally I lay very much less stress upon the engineering teacher's knowledge of his profession than I do of his understanding of men, his tact, his ability to understand students and most important of all a real sense of humor. I believe that is a prerequisite for all teachers.

W. S. Franklin: When I get up to speak, urged by my own impatience, I can generally make you smile, but when I am made to get up and speak like this I am flabbergasted.

Of course, Mr. Chairman, I realize, as we all do, that the most serious problem that we face in our educational work is the teacher problem, and I think some of the older among us have come to believe that the most serious problem in connection with the teacher problem is to teach the teachers. I still believe, and always have believed, that the greatest difficulty encountered in the advancement of teaching is the inertia of the teaching profession. And I think that is true among engineering teachers as well as among those in the secondary schools.

I do not believe I fully agree with Dean Anthony in relegating to a position of secondary importance the question of "understanding his subject"; and yet I do thoroughly agree with the proposition that a sense of humor is extremely important. Now, as a matter of fact, I do not believe that I ever discussed a subject with a student, before this body or any other organization, but that the whole thing seemed more of a joke to me than anything else.

I want to qualify that statement by quoting from Dr. Drinker, the former president of Lehigh University, who was

without question the most tolerant man I ever knew. I had many occasions to know of his tolerance because I was on many occasions a thorn in his flesh. I never knew a man for whom I had greater natural affection than I had for Dr. Drinker, and I remember that on one occasion we had been discussing a question in faculty which some members of the faculty were taking with extreme seriousness—not only the topic, but taking themselves with super-seriousness. After the meeting Dr. Drinker and I happened to be together and the conversation was very slow, but deep in mutual understanding and he said: "Franklin, the most important thing in this world is to understand the fact that after all nothing makes any difference." And when I come face to face with a question which seems impossible of solution, as how to hold desirable young men in the teaching profession, I always find relief in that remark of Dr. Drinker's "That after all, nothing makes any difference." This is the most complete expresson of the spirit of patient tolerance I have ever heard. And I shall never forget it.

Of course in discussing a question of this kind I might interject a personal motif to the extent of saying that I have always been extremely regretful that so few students of mine have become teachers—and that remark applies to my own two boys. I wanted them first of all to teach. Failing in that I wanted them to become engineering students, and get into engineering or scientific lines of work; but they were too well acquainted with one teacher, and with one would-be scientist to be seriously attracted by these fields. I can count on the fingers of my two hands and the toes of my two feet and the hairs of my head, for many counters are needed, my students who would have made good teachers and heads of engineering departments but who almost without number have been drawn into industry; I do not know what we are to do about it.

I sometimes doubt whether the question of salaries is the most serious element in the situation. We all know that a teacher who works during his vacation instead of idling and

loafing has many opportunities to supplement his income, to stimulate his growth, and to widen his influence, the writing of books, the participation in meetings of this kind, the doing of scientific work, and the engaging in engineering.

It seems to me that any teacher of engineering who does not slop over into some of these fields falls very far short of his great opportunity. It seems to me we must not expect our teachers to round out lives solely through their teaching activities. If they do, I do not think they can be good teachers. If they do we know they cannot make a living. If they do we know they cannot do justice to their students.

I am frequently struck with the conviction that teachers get, after all, pretty nearly what they deserve, and I do not like our practical men who come around and talk to me after this strain. "Oh, you poor teachers! It is too bad you don't get $50,000 a year. They don't mention figures, but that is the real interpretation of their remarks that we don't get from $50,000 to $250,000 a year."

I have come to believe that our most important problem is to catch the teacher and get him started; and if once our best young men be started in the teaching profession, by offering them as much as they can get in the beginning in practical work, it seems to me that there is a wide opportunity in the engineering teaching profession which must certainly operate to hold them in service through life. I am not pessimistic about the matter at all.

W. G. Raymond: Well, I doubt if anything is being done to improve the personnel more than has been done in the past—that is, we simply get the best we can. We have in the schools over the country increased our salaries somewhat. And possibly that will make our profession more attractive.

I confess I hesitate myself to ask my brightest graduates to go into teaching. I think the field is a good one for certain types of college men, but as a rule I hesitate to even suggest that they go into teaching. I always hesitate to ask any of our own graduates to go into our own teaching staff. We prefer

very much to recruit from the outside so that we may have some new ideas. We do one other thing which I suppose the rest of you do. We get new instructors from time to time, and if they do not prove satisfactory we try to make it convenient for them to find some other place, and if they do prove satisfactory we try to advance them as fast as we can so as to make their places attractive for them.

On the second question, I do not know that very much is being done to improve the training of teachers for their jobs. We are not doing much of anything in that direction, but we do insist that they shall engage in practical work, so far as it may be possible, during the vacation time, and we also permit them to engage in the work of their profession during the school year so far as that is possible without interfering with their class work.

I must confess that I do not know that anything is being done to improve the teacher in his work and make him more efficient except to encourage him to become a member of this institution, and considering the statement that Mr. Burr made yesterday I am not quite sure whether that is an effective method or not.

Chas. F. Scott: You have said some very nice things, Mr. Chairman, but it does not surpise a Yale man; that is the way we do things at Yale. I will say that it does seem to me that the real problem in engineering education is the developing of the right kind of teachers, because engineering teaching underlies the engineering profession.

The number of qualities a teacher must have is surprising. A man may have ninety-five per cent. of the qualities required in a teacher, but the lack of the other five per cent. may spoil his effectiveness as an instructor.

The academic evolution of the professor is this: The graduate becomes a graduate student, an assistant, and after a few years an instructor, and after another few years an assistant professor. I think the Yale tradition has been that a man should not become an instructor until he had received his second degree.

But in engineering we need something different. The student who has just graduated does not have the engineering experience the perspective and point of view to do good engineering teaching. The man we want is the man of experience, not only in working for his advanced degree, but in doing other things. The qualities which make a man a good engineering teacher are not necessarily those which are gained through a continuance of studies which lead on to advanced degrees and the writing of many theses and researches and publications. What we do want is a solid and substantial fundamental training. We want perspective and experience. We want a kind of personality which includes such elements as have been emphasized by those who have addressed us during the last few days. We want men who can inspire and lead; we want men who can teach. The engineering teacher cannot be gauged by the same things that teachers are gauged by in other departments.

The demand for the promising young man out in the industries makes it hard to make teaching attractive. Moreover, teaching in general seems to be not so popular. I think I am correct in saying that the number of Yale graduates who have listed themselves with our Bureau of Appointments for teaching positions is very, very small, although there is a large demand for teachers. Graduates want to go into other branches of life.

I am emphasizing the problem rather than presenting a solution of it. We must do something to add greater attractiveness to this work, such as better salaries, possibilities for advancement, and facilities for outside work. We must develop and dignify the profession of engineering teaching.

One other thing, in the individual institution, and through our monthly bulletin, whatever we can do to contribute definitely and concretely to the methods of teaching, particularly to elementary teaching, the greater advance we will make.

President Hadley called attention to one important factor yesterday, which is the need of greater financial economy in

teaching, greater effectiveness in getting the student to do more of the work.

One of our commencement speakers last week at the alumni meeting said that one of the great assets of a teacher is ability to keep his students interested. Interesting the student in the subject should be the teacher's method instead of driving and threatening. Whatever through discussions in individual institutions, and through our monthly publication we can contribute in the way of concrete methods and ways of accomplishing results of that kind, is one of the means by which the Society may be effective in promoting engineering teaching.

J. H. Felgar: When we have so many applicants for positions as teachers as we have now in the present depression, I think the most important matter to be considered is their educational qualifications and next their personality. We do not do as they do in the secondary school system, check up their ability to teach.

In the teaching profession in the colleges a man falls into it and his ability to teach is largely from a personal qualification rather than from any special study.

As to this second topic, we should make an effort to do something along this line. There are fundamental principles of pedagogy which our schools of education advocate, and it should be the part of those who have charge of engineering teachers to make an effort to bring these to their attention. I think that there are some teachers in college who do not realize that one of the fundamental elements in teaching is the attention. We depend largely on the personal quality for securing attention. One of the things we can do, as one of the gentlemen suggested, is to have round-table conferences with regard to engineering teaching, and endeavor to get information, from the teaching force itself, or those, in the college, who know about these things, and have these matters presented to our teachers.

One of the things that can be done is for those members of our faculty that are members of this Society, to see that this

matter is given greater attention—and a good plan would be to use the *Bulletin*—you will often find articles in the *Bulletin* which would be useful for discussion, in methods of teaching. The Society sends three copies to the institutions—it is supposed that the president reads one, the other two go to the library. It would be a good plan to mark these copies of the *Bulletin* and send them to teachers who are teaching the subjects treated in the *Bulletin* to prevent that material from going to waste and bring to the attention of our teachers that there is such a thing as pedagogical presentation of a subject as well as knowledge of it.

FOUNDATION MATHEMATICS, PHYSICS AND CHEMISTRY FOR ENGINEERING STUDENTS.

BY GEORGE B. PEGRAM,

Dean School of Mines, Engineering and Chemistry, Columbia University.

For the individual student of engineering the study of such subjects as English, or history, or Latin may have laid more important foundations for his education than any of his scientific studies, depending mainly on the influence of his several teachers, but for engineering education as distinguished from other types of education, the outstanding characteristic is that mathematics, physics and chemistry are its foundation subjects.

As we observe and talk with our graduates, do we get the impression that they got in our schools the opportunity to lay adequate foundations in the knowledge of these sciences? My own impression is that the engineer who begins to advance in his profession is very likely to express his wish that he had gone further with his study of mathematics or physics or chemistry, while he is much less likely to regret not having had enough training in technical subjects such as machine design, or structures. The more technical subject he realizes he can work up as he needs it, but he feels, perhaps unduly, the difficulty of going back to a thoroughgoing study of physics, for example.

If a considerably large part of the student's time in school were spent in study of the fundamental sciences, would we hear complaints from our graduates of the lack of training in more technical courses? Of course we should hear complaints from our undergraduates because the majority of them are not going to be engineers, lacking adaptability or endurance for the preparation required and being af-

fected always by the natural human tendency to discount the value of preparatory study and by the hope of arriving quickly at a knowledge of engineering by getting directly into more technical studies. But as to the men who actually graduate and go into the practice of engineering, it is my impression that we should hear of little complaint and much satisfaction if the study of the fundamental sciences were accorded a considerably more important place in the curriculum than at present. But any such test of shifting the emphasis somewhat more toward fundamental scientific training and away from the more technical courses could properly be made only with other conditions the same. If the student has a longer course in physics but comes in contact only with a young instructor or assistants, and loses thereby a more technical course under an experienced professor, the comparison as to subject matter is imperfect. I have just heard of one large engineering school in which all the general chemistry instruction was in charge of one instructor and a group of assistants, the instruction costing the university for salaries about seven cents per hour per student. Under such circumstances an argument that the student should spend an increased amount of time on the fundamental subject of chemistry and less time on a technical course such as chemical factory management, taught by an experienced professor, loses most of its force. It can only be in those schools in which mathematics, physics and chemistry are as well provided for in the grade of instructing staff as the strictly engineering subjects, and in which no attempt is made to cheapen the instruction in these subjects, that satisfactory results may be expected.

We are familiar with the fact that the actual allowance of time in the curriculum to the foundation sciences results from more or less kinetic equilibrium, pressure on the part of engineering departments for more time for their specialties, aided a good deal by the undergraduate desire to see what engineering is really like, opposed by the desire of the scientific departments to do more creditable work and of the

engineering departments to have the student better prepared for their work. When the equilibrium point gives the whole subject of physics, for example, four hours a week in the freshman year, the result is sure to be unsatisfactory. There is little danger of too great a time allowance for these subjects, the curriculum being too closely watched for openings by the vitally interested engineering departments.

One phase of this subject is of particular interest to the school I represent and of some interest to all the larger schools. Many students are coming into engineering schools after spending two or more years in college, and many colleges are offering some elementary courses in engineering. We find that comparatively few of these students from colleges have a good grounding in mathematics, physics and chemistry, but many of them have taken, with little real grasp of the subjects, courses in electrical engineering, power machinery, etc. These colleges would serve the students who are really to make anything of engineering far better and more honestly by strengthening their instruction in the fundamental sciences and letting it be known that a knowledge of them constitutes the best preparation for further study of engineering rather than by maintaining, on slim foundations, such technical engineering courses as they are able to provide.

For example, in the pre-engineering course in Columbia College we obtain satisfactory results in physics by a course on general physics for six hours a week for a year and a half with one afternoon a week of laboratory work for a year. This course in physics begins after the student has had his differential calculus.

If the scientific knowledge of the graduates of our schools has indeed proved too superficial for present needs we may believe that it will fall far short of the demands of the future. Engineering becomes steadily more scientific, more alert to utilize effectively the very newest ideas and discoveries of pure science. Our engineering education should take full account of this and assure to our graduates a funda-

mental scientific training so good that as science develops they will be conscious of the power to follow it and not be depressed and inhibited by the consciousness of never having attained a firm grasp of mathematics and physics and chemistry. I should propose nothing revolutionary, but would recommend a firm and steady policy of increasing the emphasis on the study of the fundamental sciences, avoidance of short cut and make haste methods to get around them, and of strengthening the instruction in this field by better teachers and larger time allowances, on every possible occasion.

ROUND TABLE DISCUSSION.

M. S. Ketchum: I have found that there is considerable difference of opinion as to what subjects are fundamental and what are not. Recently I have been told that engineering instructors do not give fundamental training, and that fundamental training can only be given in the departments of pure science. That is a mistake. In the civil engineering department with which I am connected there is given in the junior year a course in graphic calculus which is certainly as fundamental as any work in the mathematics department. Work is given in mechanics, sometimes called physics, which certainly is as fundamental as any work in the physics department.

I think the important thing is that the student be given fundamental training. It does not matter where it is given, but it is important that the man giving it has had experience in the applications as well as a thorough knowledge of the subject itself. The amount of time given to physics, chemistry and pure mathematics will depend not only on the organization of the institution but also very much on the personnel in the different departments.

The important thing is that when the student has finished his work he should be well grounded in the fundamental sciences, mathematics and mechanics. There is another thought, and that is that the student does not get anything more than a smattering of these subjects on the first contact. Some students are almost immune, and it is necessary in many cases to bring them in contact with the subject from the sophomore year until the entire finish of the course. To do this, it is important that the work be correlated so that the students will get that frequent contact and also some idea of the use of fundamental sicences, and that they will continue to grow, even after they have left college.

Prof. W. S. Franklin: I would like to make two diametrically opposite statements on this particular subject.

The Chairman: Two diametrically opposite statements to what?

Professor Franklin: To each other. The first is that numerical problems are absolutely necessary in the study of any mathematical science, and the second is that there is no field in which there is so much time and effort wasted by the students as in the solution of problems; most problem work being done unintelligently by the students.

The Chairman: A few years ago we looked to the departments of science to teach our men science, and then we look over here to another department to teach them engineering. That has all disappeared. There is no boundary line between pure science and applied science now; and the reason you do not know calculus, most of you men as old as I am, is because you did not do it. The boy today learns the calculus by applying it, using it, doing it; just as the engineers have learned.

F. A. Fish: This is the second year we have been giving this course of problems for freshmen at Ames. A report was made last year by one of our faculty on the method in detail.

The freshmen are divided into sections of about 20 men each and work one period of three hours each per week, under constant supervision and direction of an instructor. The purpose of the course is largely drill in mathematical computation and in logical organization of material. The problems are simple ones in mechanics.

C. F. Allen: It seems to be pretty well established by Mr. Pegram's paper and Mr. Ketchum's that the proper aim of our engineering colleges is suitable theoretical instruction. To me, what the engineering colleges of this country stand for, as compared with previous agencies of instruction, is that theory can be taught to the best advantage only in connection with its application. One illustration of that was given by Professor Scott. That is the general broad principle which I wish to bring out.

R. G. Warner: After graduation I spent a few years at the Westinghouse Electric & Manufacturing Company and was fortunate in being selected with about twenty other cadet engineers for special training under the direction of Mr. B. G. Lamme, chief engineer of the company. It is of interest that the problem method of instruction is used in training for the engineering department of this large industry. A considerable number of questions pertaining to one type of apparatus are given at a time. The questions, prepared by the specialists for the particular type of apparatus, are typical engineers' problems. The cadet engineers answer them with the engineers' tools, reference literature, the factory, observation, discussion among themselves, etc., any source except the company's specialists.

The solutions to the problems are in general dependent on economical design but some are directly dependent on mechanical features, others on electrical or magnetic features and others on shop production or even the psychological effect on either the workman or the purchaser.

The questions are of many different types, for instance: "The usual thickness of armature laminations is .017" (17 mils). What are the various reasons, mechanical, electrical, and commercial, which fix this particular thickness?" Or in regard to direct current generators: "What are the reasons for the use of the slotted construction in armatures?"

A. P. Folwell: The remarks of the previous speaker remind me that some years ago, when I was teaching undergraduates instead of post-graduates as I do now as editor of a paper, I introduced the problem method in my course on sewerage and water supply, my aim being to stimulate the imagination of the students rather than merely to illustrate the application of principles already learned.

One of the problems given to the students shortly after beginning the course was the following: Having learned that sewage was a fluid and flowed like water, and a few of the practical principles involved in designing and constructing

sewerage systems, including the elements of such a system, such as manholes and the like, I would ask each student to prepare a design of a manhole. He would be directed to consider all of the purposes to be met by a sewer manhole and then to design a structure best fitted to meet these requirements, "best" including strongest, most durable and most economic. He would consider the various materials available, such as brick, concrete, wood, etc. Selecting the two most suitable, he would prepare a complete design and bill of material for each and estimate the cost. These would be brought to the class and then all of the designs would be compared and discussed.

The idea in my mind was that while many young engineers have learned the general principles, when given a specific case to design they do not know how to apply them. If they are to design a reservoir, for instance, they must ordinarily begin by determining from the topography, rainfall records and other sources of information the capacity of reservoir desired, necessary storm run-off to be provided for, etc. Again, they should realize beforehand that the peculiar conditions of each case will generally require special considerations in preparing a design and that no one structure should ordinarily be copied directly from another. My idea was to not only educate their imagination, but give them a realization of the fact that imagination is necessary in engineering design.

The Problem Method of Teaching.

Charles F. Scott: I think this is a subject that was proposed by Prof. Morrow of our electrical engineering department. He is not here as he is attending the A. I. E. E. convention in Salt Lake City. He has been conducting a course in electricity for non-electrical students during the past year and has sugar-coated the pill by intriguing the interest of the students.

He has used practical problems and questions as basic material in the solution or answering of which technical material

was needed but was subordinated in the mind of the student. Problems were given of factory layouts with certain specific tools or processes to be operated economically. Motors were selected of the proper speed and power to do specific jobs, speed control devices were introduced from a time study standpoint, wiring and lighting layouts were used from an economic and utility standpoint.

Or again a private power house *vs.* purchased power for a specific factory was used to introduce the technical and economic elements associated with the use of electrical apparatus in power houses. In transmission and distribution the different systems were considered from an economic and performance standpoint and the technical features were brought in to get the exact answers to the economic problems.

Computation periods were used each week in which practical problems were introduced that involved too much or too little data and required the student to use initiative and judgment. Economics were used to introduce the idea of doing the best job for the money. The laboratory work was outlined also with the idea of getting a definite conclusion on a specific question.

At the end of the year a final examination was given and when I looked over the paper there were no practical questions on it—they were all theoretical. There was something about proving the two wattmeter method of measuring three phase power on balanced circuits; something about measuring power on circuits with unbalanced power factors and loads; something about the physical and mathematical factors involved in induction motors, transformers, synchronous motors and alternators and an ideal circuit problem with a complicated network of circuit constants.

As Prof. Morrow put it, "I have been using practical things to teach theory and now I wish to find how much theory they have gained." His idea seems to be that theory can be obtained better by certain types of students in a given time if practical ideas are used to arouse their interest and the practical application is foremost in the minds of the students.

The educational question seems to be to determine how far this idea should be carried and whether it sacrifices volume of technical knowledge because of time taken for introducing the practical and economic ideas.

W. K. Hatt: We have, during the past year, operated a course of engineering projects for freshmen civil engineers. Next year this will be extended to electrical and mechanical engineering freshmen. This course proceeds through what is called the "situation method," which has been discribed in a paper entitled "Motivation," by the speaker, and published in the PROCEEDINGS of the S. P. E. E.

Our first problem is based upon a topographical map showing contours, and a valley which provides for a reservoir site, and a road. Each freshman has a copy of this map and a job sheet which presents 30 or 40 questions. The job sheet questions are not in the nature of an examination paper, but present a series of development questions which are set after a thorough analysis of the job, and by a logical course of reasoning leads the students through the problem on the basis of his common sense and general engineering knowledge. He is asked, for instance, to compute the area within the flow line of a reservoir which is produced by a dam of a given elevation. The operations are those of ordinary arithmetic and elementary mechanics. This is followed by the problem of a bridge. They are taken to the site of the bridge and obtain an elementary conception of the bridge as a whole, its waterway, width, length, and its relation to the transportation needs of the community. We try to show them that a bridge is something more than a series of lines on paper and a problem in mechanics. They are given plans of the foundations and compute the costs at unit prices that are furnished them. The relation between the substructure and the superstructure is brought out by a subsequent discussion. The list of projects as administered this year is as follows:

Study of Topographic Map.
Study of Drainage Area.

Relocation of Road on Topographic Map.
Inspection Trip to Bridge.
Study of Bridge Substructure.
Relocation of Highway to avoid Grade Crossing.
Electrical Engineering Problem in Power.

During the Xmas vacation each student writes a report upon Community Engineering Problems.

The course is considered to be a success in that the boys are interested, are "using their heads," and exercising their ingenuity. They are able to do much more than we expected. Of course there is one danger, viz., that they may get the idea that the approximate processes used in such a problem are the accurate methods that an engineer uses. This difficulty is met by a review of the exercise at the next meeting of the class. The problems are not graded individually, but are returned to the student for correction at the next class meeting.

We feel that there is a distinct gain of time from the standpoint of the teachers in mathematics and physics. It attaches these abstract subjects to realities and the applications of the accompanying mathematics in the freshman year are seen to be of value. Furthermore, we attempt to present the project in all its phases, so that engineering is not taught in separate compartments.

The course is accompanied by a series of general lectures on engineering showing what is done in the different branches of engineering on more heroic planes.

Engineering Extension.

E. D. Walker: While I am not connected with our extension work I am nevertheless somewhat familiar with what we are doing and will give you a résumé of what we have done and state some plans which we expect to put into effect this fall. Our work in the past in the Extension Division has been mainly with men in the shops desiring to take work in shop drawing, arithmetic, building construction, electricity, gas engines, gas producers, though we have also given some courses in oxy-

acetylene welding, and in industrial organization and management. Classes have been organized throughout the State of Pennsylvania. In some cases we are working through corporations; in some cases through the local Y. M. C. A.; and in some cases through the trade unions. In all of these cases we have a resident supervisor and we also keep in touch with the work through our travelling representatives.

In addition to the work done through the classes we also have supervised home study classes handled by correspondence. This work is also looked after by the local supervisor who arranges to be at a certain point at a certain time convenient for a group of those taking the work in this manner. If some men have neglected to send in the answers to a given lesson through discouragement or some other cause, the local supervisor makes it a point to look up those men to find out their difficulties and if possiible arrange matters so that they can continue. These home study courses have an advantage over the class work, as the different individuals have different degrees of preparation. The better equipped man can go ahead as rapidly as he is able without being held back by the others. The less well equipped men are not so likley to be discouraged by seeing others going along without experiencing difficulties due to the lack of preparation. We have now had this method in operation for about two years and find a much larger percentage of completions as a result.

While we have given some work of college grade in the past this has not been as prominent a feature as it will be in the future. We are organizing a division of extension work in which the subjects taught will be of college grade and for which college credit may be given if the man should later decide to come to the college for residence work. We have in mind three classes of students who will be benefited by this work. One consists of men who have graduated in engineering but wish to pursue subjects in advance of those which they took in their college courses or along different lines of work from those covered in their undergraduate work. A second group

consists of students who have been obliged to drop out of college for financial reasons but who may wish to pursue their college studies to a certain extent while they are earning money to return. The third group consists of men who have not yet entered college but who are earning money for that purpose and who may get a start before enrolling for resident work. A man has been engaged to supervise this division of extension work.

At present we have about 7,000 students enrolled in the extension courses.

R. A. Spahr: I wish to refer to a development in Engineering Extension which may be of interest to the members of the S. P. E. E. It is yet in the experimental stage, pure and simple. I was looking around to find instruction for some of our people at the Winchester Repeating Arms Co. I went to Professor Breckenridge representing the Mechanical Engineering Department at Yale to see if he could help me, and he informed me that he had no money available for such work, so I have been working up a plan which is something like this:

I made arrangements with the University of Wisconsin Extension Division to supply engineering courses which will be given through the Educational Division of the Manufacturing Co. The paper will be handled through my office and sent in to the University of Wisconsin for grading. All the people who take the courses of collegiate grade and those for which the University of Wisconsin gives credit will be taken care of by them in their home office. Young men in the plant who show promise may work under the supervision of my office and also the University of Wisconsin, and at some future time we hope to guide quite a number of men to the University of Wisconsin Engineering School; not to the University of Wisconsin, because it is the University of Wisconsin, but because they have the most highly developed organization for handling this system of instruction.

The results of this plan are not yet available, but it looks as if there might be 50 enrollments in various subjects by next

fall. Until Yale is in a position to furnish such instruction we will be compelled to go elsewhere.

The Chairman: There was a time when the West looked to the East for educational help and it now looks as if the East is looking to the West.

C. F. Allen: There is one phase of this subject that I would like to speak of, which is a little different from what the other speakers have touched on. I want to speak of the Lowell Institute courses for the Training of Industrial Foremen which come under the general lines of this work. The professors who have charge of the different classes there have told me how successful some of their work has been. I commented on their statement and said that much of the success was due to the fact that with the new constituency they were teaching with more care since they found that they must teach to the needs of the students as they found them.

I wish to bring out the fact that the reaction upon the professor in making him a better teacher all the way round is an element that should not be lost sight of in this work.

J. Daniels: At the University of Washington in Seattle we have a development in mining engineering slightly different from that now under discussion. During the winter season, which starts about the first of January and continues until the latter part of March, a number of mining men from Alaska, British Columbia and the states of the Pacific Northwest come to the University as short-session students. The courses which they enter consist of geology, mineralogy, surveying, mining engineering, milling, fire assaying, and some instruction in hydraulics and placer mining. The men range in age from twenty-one years to fifty. In many cases they come back for a second year for "post graduate work," as they call it, specializing on some phase of a problem that is of particular interest to them; for instance, a miner may have a refractory type of ore which he is unable to treat satisfactorily. In connection with his work at the University the student is enabled to conduct such tests on it as he thinks will

enable him to successfully treat the ore and convert his prospect into a commercial possibility.

These short-session students have learned that the instruction they get is of practical benefit to them in their work, either as prospectors, miners or even as business men with mining interests. We have had a great deal of success with this type of instruction, which has been given annually at the University of Washington for twenty-four years. The men enjoy all the privileges of regular students in residence; not only do they get a great deal of real help, but every instructor and student who comes into contact with them receives a great deal of benefit from the association and the exchange of ideas brought about by their presence in the institution.

M. S. Ketchum: Last year the Civil Engineering Department of the University of Pennsylvania gave a brief course in highway engineering. This course was intended for men who had had considerable experience in highway engineering construction. The course covered three weeks' time, two weeks being given to lectures, recitations and laboratory work, and one week to a highway engineering conference. The brief course was attended by sixty-seven men, varying in age from twenty to fifty-nine years. Many of the students were technical graduates, and several were members of the American Society of Civil Engineers. This course was carried on in coöperation with the State Highway Departments of Pennsylvania, Delaware, New Jersey and Maryland, the Bureau of Public Roads and the engineering department of the City of Philadelphia. The laboratory instruction in the testing of road building materials was given by experienced testing engineers from the laboratories of the State Highway Department and the City of Philadelphia. The instruction in roads was given by an assistant engineer of the State Highway Department, while the instruction on brick roads was given by a consulting engineer connected with the brick industry. The results were very satisfactory, and apparently we will be asked to give the course again this year.

C. S. Howe: The headquarters of the National Electric Light Association, so far as its experimental work is concerned, is in Cleveland, Ohio, where it has a beautiful place known as Nela Park, laid out like a college campus. Some years ago we asked the association if it would direct the course in illumination for our students. It agreed to do so and its men give nearly all the instruction in that course. The classes are held three times a week. The association sends its best experts to lecture to our students and we pay them a small fee.

The association pays one half this expense and furnishes a large part of the apparatus, so that it is helping us materially as well as loaning us its men. This course is very valuable to the students taking electricity and we think it is also of some value to the lamp association because it gets some men for its work in illumination who have been trained in our laboratory by its own experts.

L. P. Breckenridge: Taking advantage of his environment is an essential thing which the engineer must do. Perhaps a word from the chairman relating to the engineering laboratories at Yale might be in order. The mechanical and the electrical engineering laboratories coöperate quite freely to our mutual advantage. We usually have in our laboratories more material and apparatus than you see there now. Much of the equipment in the mechanical engineering laboratory is on loan to us. We experiment with it for six months or a year sending reports of tests to the builders, then it goes out and other material replaces it. It lessens the cost to the department to have this apparatus loaned to us and in addition it keeps the department in touch with the industries. This plan is working out exceedingly well in this particular environment. We do much the same thing with regard to some of our research work, working closely with the industries. Doing work in this way has a great educational value and is of much interest to the student. Working on these industrial

problems is of advantage to the industries concerned and we find this coöperative work of benefit all around. Thus coöperation with commercial organizations and industries applies not only in teaching but in research.

Professor Walker: There is another form of coöperation which we have started on at The Pennsylvania State College, and some very good results have already been achieved, growing out of a series of what we might call industrial educational conferences held in the past two years and we will probably hold another conference next Fall to which we have invited representatives of various corporations, engineers in different lines of work, mechanical, electrical, etc., for a two days' conference and exchange of ideas.

As has been mentioned by some previous speakers, engineers in practice have their own ideas regarding education and how things should be taught, and also what should be the content of the college curriculum, and we invite the engineers who come to us to express their views freely. We do not care if they tear our course to pieces, so that we get some constructive criticism out of the suggestions they make. We have received some suggestions in that way.

Another thing—we have succeeded in getting into touch with corporations which have graduate apprenticeship schools. Many corporations have such schools in which they take a graduate from one or another course of engineering, and put the man through a course of training, varying from one year in some cases to two and one half years in other cases.

One of the questions we put up to the representatives of these corporations was whether or not, taking a man during the vacation following the sophomore year and the vacation following the junior year, they could start him on the course which they had for college graduates, enabling him to get a certain distance along in that training, and after he had completed the course at college give him credit for the number of months he put in in the industry during his summer vacation.

None were willing to accept work during the vacation fol-

lowing the sophomore year and a few have expressed willingness to accept men at the end of the junior year, and put them in the apprenticeship courses and count that in the time ordinarily required after graduation.

That is one form of coöperation we have succeeded in getting started with a few corporations in addition to some of the things referred to by the previous speakers.

H. B. Shaw: I wish to make a suggestion. I believe that the National Electric Light Association will be glad to coöperate. This matter was presented by Professor Scott and I hoped that a representative of that association would have been here to tell you something of what they have been doing along the lines of information service to member-companies, to protect their investments and secure them reasonable returns for their service, and in general to stimulate and help each of the companies in carrying on their business which is of great value to the customers and the communities.

I make the suggestion that we express in some way the desire, if there is a desire on the part of the Society for the Promotion of Engineering Education to coöperate with the National Electric Light Association.

I believe that teachers can get an immense amount of information as to operating problems, similar perhaps to those along the line of the problems gotten up by the American Institute of Electrical Engineers, and as a teacher I found that these were most interesting problems, and very hard to get, because there is not much publicity about utilities operation, or was not at the time I was teaching, and also because it is a continually changing and improving situation.

COOPERATION WITH COMMERCIAL ASSOCIATIONS, SUCH AS N. E. L. A.

Charles F. Scott: The National Electric Light Association has taken a very active interest in this matter of education. A few years ago it had an educational committee and on it a number of professors, some from the east and some from the west. It brought them to New York for a conference once or twice a year.

The companies of the association are doing a good deal of industrial educational work through the organization of classes and the like which is proving very beneficial to the employees and to the companies.

The association is anxious and ready to coöperate with the colleges in furnishing speakers, for bringing out both the engineering and economic phases of public utilities and in taking students through their plants, etc. Many companies have established cadet courses for graduates and are pursuing a broad and active policy in regard to matters of education, realizing their dependence upon the college for its men in the future.

While we have been hearing a great deal about the difficulties that the utilities are in at the present time in the way of high costs, etc., and have been wondering whether they are going to pull through, I was astonished at the note of tremendous enthusiasm and confidence in planning for the future at the meeting of the Association in Chicago a month ago. The keynote for the power industry with regard to its power plants and distributing systems, is that their development to meet public needs will call for an expenditure of many hundred million dollars annually during the next five years. The raising of this increased capital will require a good deal

of financial effort, and it is also going to mean a good deal of engineering effort to see that the amount of money is properly expended in efficient way. The curve will not stop at the end of five years, but will continue to rise and that is one indication of the need for producing engineers who can handle large work in a large way.

ANNUAL DINNER.

PRESIDENT COOLEY: Tomorrow you are going aboard ship and put to sea. Sea-going knowledge is for most of you I presume confined to that which comes from seeing a ship tied alongside of a dock; but tomorrow you are going to sea, and you are going to see in two senses—sea and see. The Navy Department has put to our service three Destroyers.

We have been highly favored. We had hoped to have the Secretary of the Navy with us tonight but he sent President Hadley a telegram explaining why he could not come.

"DR. ARTHUR TWINING HADLEY,
Yale University, New Haven, Conn.

"Thanks for the courteous invitation of Yale and the Society for the Promotion of Engineering Education for dinner June thirtieth. Regret however previous engagement will not permit acceptance. Please extend to those present my sincere good wishes for their success and welfare.

EDWIN DENBY."

While we could not have the Secretary we do have with us Lieutenant-Commander Oscar C. Badger, the commander of the *Pruitt,* and the commanding officer of the 48th Division. We also have Lieutenant B. B. Lanier, Commander of the *Biddle,* and Lieutenant M. B. Derx, Commander of the *Pope.* When you address the commanders of these different ships it is quite correct for you to call them "Captain."

The gentleman who is next to speak to us is the son of Admiral Badger. In my day at the Naval Academy, he was a Lieutenant and taught, or tried to teach, me mathematics.

It is for me a great pleasure, indeed, to meet the son of Admiral Badger, and let me assure you this is no ordinary or garden variety of son in the Navy, for he is the fourth

generation, of which four fathers and four mothers were all naval sons and naval daughters.

Let me call your attention to something which will demonstrate better than anything else how the Navy has advanced. I graduated in 1878 and Lieutenant-Commander Badger in 1910. My class-mates were Lieutenant-Commanders at the age of 43, or thereabouts; whereas Captain Badger is a Lieutenant-Commander at 30, or somewhere around there. My first ship was the *Quinnebaug*. She was a wooden ship —a rebuilt ship. In those days Congress would not appropriate any money for new ships, but would appropriate money to repair old ships. So they took the old *Quinnebaug's* bell and built a ship around it. She was equipped with compound engines—almost the first in the Navy. They were the old low pressure engines, with a high-pressure cylinder inside one of the low pressure cylinders. The *Quinnebaug* had high-pressure boilers, called by the suggestive name "powder keg" boilers. They were eight feet long, eight feet in diameter and had brass tubes, which had the vicious habit of burning off at the ends and dropping out.

The Navy Department promised that the *Quinnebaug* would go to the Mediterranean Station if she made fourteen knots on her trial trip. Well, she made it. But never again. The old *Quinnebaug* was a ship of 1,000 tons or less, and about 1,000 or 1,100 horsepower.

Now, tomorrow, you will see a modern ship, the latest destroyer, longer but not so much larger than the *Quinnebaug* but instead of 1,100 horsepower she has 30,000 horsepower; and instead of 14 knots she makes better than 35 knots. But let the new Navy speak. I have great pleasure in presenting Lieutenant-Commander Badger.

ADDRESS.

Lieutenant-Commander Oscar C. Badger: I surely cannot express the honor I feel in addressing you and in having the opportunity to represent the Navy here. And I am

sure any naval officer would feel likewise. But I have not had an opportunity to prepare an address.

This reminds me very much of my father, an old sailor man who rubs it into me at times. He says: "You do not have 'opportunity' to get to sea. You don't go to sea, nowadays, for 180 days without sighting land; you have electric-toasters on your table; but when I went to sea I did not toast my bread, but ate hard-tack," etc. This word "opportunity" even extends to speech-making for I heard him preparing the last one he delivered.

He was then to address the D. A. R. as a representative of the Aztec Club, and we could hear him in the bath-tub rehearsing his speech, saying "Ladies, I am here as the representative of the Aztec Club."

But speaking seriously I realize that you are assembled here from all over the United States; and having relatives —a good part of my family—in Minnesota, I realize that many of you have opportunity to consider what the Navy is; what the sizes of ships mean, and what the Navy is doing? I know a great many people in the country districts are not well-read; and many of them look upon the sailorman of the old type with certain erroneous views; they who belonged to the ships of fiction or of the olden time. The modern man on a ship is not a man to look down upon as to his habits. The modern sailorman is a young specialist; and the modern navy is the greatest conglomeration of engineering specialties that exists anywhere.

The engines of to-day are very powerful. The destroyer engines of 30,000 h.p. or slightly more, represent actual shaft-power; that is, the torsion-meter readings on the shaft that drives the ship; and does not include auxiliaries. The battleships and dreadnoughts have from 16,000 h.p.—such as the *Michigan*—to close up to 40,000 h.p. on the modern dreadnaughts; and then we rise higher to the battle-cruiser of electric drive with 180,000 h.p. and 45,000-kilowatts units in one generator.

The man to-day on board ship comes to us as an uneducated boy. He comes very young, a rooky. Does not know

how to wear his clothes, and he gets seasick. And we tackle him and try to train him into being a gunner's mate, a machinist or other specialist. Gunnery is nothing but engineering work. Those boys in my opinion are the finest type of young men of comparative salary and pay in this country. I think after working two years in the shipyards, and seeing the enthusiasm which exists there, that I would compare the Navy enthusiasm, in connection with the reward that they get—well, I cannot say too much for it. You simply must appreciate the work these blue-jackets are doing. They are men through and through; and you can well be proud of them. If some cannot be so classed they do not last long in the Navy.

I spoke of gunnery: When you think of being able to fire from dreadnoughts 42,000 pounds of shell every minute; each travelling at the rate of half a mile a second; and consider the designing and the forces behind that shell; and that it is fired from an island, so to speak, a floating fortress; then you can realize the power we have and the control on board the ship. And right there is where we come into contact with the gentlemen ashore in the engineering profession. We are dependent on you for new ideas. We are like sponges; we absorb your ideas and we make the most of them. We would like to have more ideas; and we would be glad at any time to receive a man's ideas who knows nothing about the service, for "Out of the mouth of babes," etc.

We try to do the best we can with the tools we have. We realize we have not the opportunity to specialize—we officers in the Navy—that the man on the outside has. And you must not hold back because these are not war times, and think the Navy does not need your assistance—for it does. We cannot afford to specialize. Our greater number of officers have gone into the broader training, so that the man on the bridge knows something of his engine and his shaft; and is therefore a better commanding officer. But his training as a commanding officer takes him away from

the engine-room, so he is not, therefore, a lifetime specialist. But he makes a better naval officer, and a better commander; and when you speak of engineers in the Navy do not belittle them because they have not the wider opportunity to specialize. We often depend on the men ashore to work out our problems, which we then do our best to apply.

As far as economy is concerned, everything in the Navy is competitive; and the ships' standings are published. In the last seven years I have been in the torpedo flotilla we have made strides in the matter of economy: We used to burn twice as much oil, fuel oil, with lighter ships, as we do now.

The *Parker,* built in 1911, burned 3500 gallons of fuel oil at 29 knots per hour. The *Pruitt,* my present ship, can make 35 knots to 36 knots (with a tremendous increase of the curve at the higher speed) with about 3400 gallons. That is to say, we double the horsepower, practically, with less fuel oil in the boilers.

Now, then, there is only one more point that I wish to bring out. Every man in the Navy is proud of his ship and of his uniform. If he is not he does not last long; he does not make good. If you see a blue-jacket who is not proud of the service you may trust to it that his career in the Navy is or was short. We all love our ships and the Navy, and I hope when you return to the various communities, you will remember what I have told you tonight and what you may see on the ships tomorrow, namely, that the men in the service are a fine class of young men, as fine as any in the country. And, further, I want you all to know how much we depend on the civilian engineers for ideas and suggestions for improvements. Don't hang back simply because we now have peace times. Remember that we are now trying to maintain a Navy with one half the number of rated or experienced men we should have. Every ship is shorthanded in this regard. Men have left the Navy in droves owing to the higher wages they could obtain outside; and they have left in their wake many men of inexperience and youth who require training from the ground up.

Again, I certainly want to express my appreciation, which I do inadequately, for the way in which I have been honored tonight, and I only hope that tomorrow I will be able to bring out some of the good points of the Navy, and be able to show you all you care to see. There will be no secrets from you; all your questions will be answered, and full explanations given. So don't fail to come tomorrow. As to the weather, all I can say is: If it is a flood, it is a pretty good thing to be on a ship.

I thank you.

CALVERT TOWNLEY: When Professor Scott was good enough to ask me to come and talk to you, he said, "We would like to have you come. Come if you can, but there will be plenty of good speakers, and it does not make much difference whether you really come or not." So I thought; that will be all right; I will probably speak near the last, and I can say: "I am glad to be here. Devote the rest of my time to applause." Therefore, I find myself in a little hole—although not such a hole as Jones is in, who was buried yesterday.

Now, after partaking of this delightful repast, I remember a little sign I once saw in a restaurant in a small town in Missouri, which read: "Don't divorce your wife because she can't cook. Eat here and keep her for a pet."

Of course, there are all sorts of views about matrimony. It was the elderly little lady with a large family who was mending socks all the time who said "Marriage is just one darned stocking after another." And it was on the occasion of the wedding of a dusky couple, when the minister said, "Mandy, do you take this man for better or worse?" She said, "Stop, right there; I never said nothin' like that. I'se gwine to take this here nigger jes like he is. If he gets any better he is gwine to die; and if he gets any worse I'se gwine to kill him myself."

Of course, these various reports and sayings come from all directions; but I was told yesterday that the dachshund was the original of the expression "Love me little, love me long."

Now, your President in introducing me said that I am interested in the American Federated Engineering Societies, the working body of which is American Engineering Council. It is a great pleasure to me to have the honor and the privilege of representing that organization before you tonight. I see a number of my colleagues in the assembled company.

If there are two facts about which all engineers are agreed, they are: first, that engineers are qualified by education, training and experience to take a prominent part in public affairs; and, second, that they do not take it.

It certainly is a fact apparent to anyone who takes the time to investigate, that engineers do not take as prominent a place in public affairs as engineers think they should. The engineer is qualified by education, training and experience to solve problems. He approaches them with an open mind, secures all available facts and reaches his conclusions solely on those facts. Then he starts after results based on those conclusions, without fear or favor.

That is the engineer's method. He attacks problems in a quantitative instead of a qualitative manner. This characteristic is a qualification much needed in dealing with public affairs.

Furthermore, the engineer has the reputation of telling the truth, because when he has solved his problem, the engineer states the results fearlessly.

Now, if it be true that the engineer is qualified to take his place in public affairs; if it be also true that he does not do it to the extent which he should; there must be some good reason. It cannot lie in the personality of the engineer because in our profession there are the same number and kind of personalities as in all other professions.

I think many of us are coming to agree as to the reason for this lack of representation. It goes back to the engineer's training; and there is where it has a direct interest for this assemblage. Of course, everyone knows—and none better than you gentlemen here—that you cannot teach a boy to be an

engineer in the limited time he is under instruction. It is not so much a question of what you should teach him; but what can you leave out. How can you give a boy the knowledge you feel it is important, in fact essential for you to give him, and to give it within the limited number of hours of instruction possible in a college course.

Engineers are specialists, and there are so many different kinds of specialists in engineering, that to teach even the basic principles of each in addition to the fundamentals is a difficult problem. It was therefore perfectly natural that the early training of the boys who to-day comprise the older men in the profession, was largely directed towards giving them such intensive engineering instruction, in addition to the fundamentals, as was possible in the available time. But those boys were not taught, or urged, to take part in affairs outside their own profession. They were not urged or taught to take part in civic affairs nor did their training specially fit them for such activities as did the training of others, such for example as the law student. Legal education comprises public speaking, the fundamentals of government and all that goes with holding office. We engineers are now taught those subjects. So when any of us force ourselves, or are forced by circumstances into public service, it is in spite of and not on account of our training.

Now many believe that the brains and the training and the personality of engineers if applied to public affairs would be a distinct benefit to our country. We believe they can do certain things better than can some other people who lack the engineering viewpoint. It is certainly true that many public questions involved engineering problems, some of them of a highly technical nature. In executive positions in handling of engineering training is of great value and it would be better for the country if there were more of it.

My contact with the educators of this country, which I regret to say is not as broad as I would like to have it, clearly indicates a tendency toward broadening the curricula in the direction of remedying this defect of this absence of instruc-

tion and incentive to the boys to undertake their duties of citizenship.

But we cannot wait for the boys of to-day to grow up and take our place. We who have long passed our student days must do what we can and do it to-day. This brings us to the consideration of the Federated American Engineering Societies. There is, as many of you know, a concerted effort now to put engineers in a position where they can be of greater service. One year ago this month—in June, 1920—there was organized in Washington a body which I have the honor to represent tonight, American Engineering Council, the working body of American Federated Engineering Societies. Delegates at the Conference represented some 115,000 professional engineers and allied technical men. They were sent by some seventy-odd engineering organizations from all over the country and there in conclave assembled united themselves together in a new bond with the slogan "Service." For the purpose of rendering service to the City, State and Nation.

We were fortunate in selecting a mining engineer as our first President, Mr. Herbert Hoover, who was not only enthusiastic about the undertaking but gave us much of his time and of his intensive energy. He was proud to be the leader of this organization and its first President. Mr. Hoover resigned with many regrets shortly after becoming a Cabinet officer. A close student of public affairs with an almost uncanny knack of putting his fingers on the outstanding facts in any situation, Mr. Hoover at once pointed out that of all the great groups formed in this country there is only one with an unselfish purpose, and that is the engineers' group.

Every other group has a selfish object; has been formed for its own interest rather than for that of the public. The prime object of the engineering group is absolutely unselfish. In it are brought together leading men from all over this country working together and at personal inconvenience for a common cause. It is a most democratic organization. The press are admitted to all board and council meetings; and all sessions

are open to the public. As one consequence the press of the country have taken a great interest in American Engineering Council, and the distribution of news regarding this organization is stupendous.

Now, if it is true that engineers are qualified to do this sort of work; and if it is true that this organization is on the right track; then I earnestly hope that it will command your kind coöperation and support. The organization has gone "over the top." It has attracted to its membership many of the large national and a considerable number of strong local engineering organizations. It has headquarters at Washington, has undertaken a number of important pieces of work and has been recognized by the Federal authorities. There are, however, still many engineering societies which have not come in and American Engineering Council can never have the right to speak for the engineers of the country, it will never have the power and prestige to enable it to do the maximum possible good until substantially every strong society has taken membership. If you believe this to be a worthy movement and that we are on the right track, you can help very much by spreading the gospel to the young men under your instruction, by urging them to affiliate themselves with their fellows in their chosen fields of activity, and not to make the mistake of working alone and trying each to make a name only for himself.

In these days of combination we do not get far without team work; and what the engineers have lacked in the past is team work. So you will be doing a valued service to all your students if you use your influence to induce them to associate themselves with their fellows, to go into the engineering organizations, both while in college and later in the national and local bodies.

Federated American Engineering Societies need the prestige of the membership of your powerful organization. The Council will never completely represent the engineers of this country until you join it.

But, we recognize that Rome was not built in a day; so, first, we would like to earn your sympathy and confidence; and if and when you find we are on the right track, do not forget that you have the most cordial invitation that it is possible to frame in the English language, to come in and join with us.

My experience in several engineering organizations is that they have all made the same mistake, they have all under-estimated their expenses. They are always short of money; and in this day and generation much cannot be accomplished without funds. Realizing that few if any engineering bodies had provided revenues to enable them to contribute to outside activities, Federated American Engineering Societies have kept its dues down to what one gentleman very aptly described as "the price of a handful of cigars a year." Some of you may not smoke, so do not have to spend money for even a handful of cigars; but our dues are low; that is the main thing.

REPORT OF COMMITTEE No. 7, INSTITUTIONAL.

The instructors' ranks will soon begin to thin out and the high standard of our engineering colleges cannot be maintained unless recruits of broad and exact training are secured. The engineering student with few exceptions does not train for the teaching profession. His life is cast along different lines and his ambition is to get into active practice. The high salaries paid engineers in the last few years have led our student body afield and have acted still more as a deterrent against teaching in the engineering colleges. Another factor that is of vital interest has been the comparative low salaries paid the teachers in our engineering colleges. Thus the high salary of practice beckoned to the young engineer and this, coupled with his natural inclination, has had its effect on the colleges and the seed corn of the future teaching staff has failed to sprout and it left the engineering colleges of America without a prospective crop of recruits of the first order of intellect. In the last three years the engineering colleges have often been compelled to have instructors, not of the highest to man the class rooms and the laboratories. This has forced many institutions to add men that were not first choice and who did not show the best promise of developing into teaching profession.

The three factors that have operated against the engineering colleges in the securing of the highest talent for its instruction staff are:

1. High salaries of engineering practice.
2. Comparative low salaries of the engineering colleges.
3. The natural inclination of the student body.

The most vital of these three factors and the most influential has been the comparative low salaries paid the engineering teachers. It has occurred to me that it would be worth while to secure a list of the salaries that are being paid the engineer-

ing professors during the current session. The engineering colleges are often connected with the College of Arts in the same institution and the salaries are often equal for the same rank. Tables A and B were collected by Dean H. Y. Benedict,

TABLE A

SALARIES, COLLEGE OF ARTS AND SCIENCES, 1920–21.

	Deans.			Professors.			Assoc. Prof.		
	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
Texas	$5,000	$5,000	$5,000	$5,000	$4,250	$4,611	$3,750	$3,250	$3,456
Alabama	4,200	3,600	3,720	3,000	2,500	2,950	2,500	2,000	2,350
Arkansas	6,000	4,250	4,750	4,000	3,000	3,275	2,900	2,600	2,750
California	6,500	......	......	6,000	4,000	......	4,000	3,000	3,600
Colorado	4,000	4,000	4,000	3,500	2,800	3,100	2,800	2,300	2,550
Cornell	6,000	6,000	6,000	5,000	3,500	4,150	3,000	2,500	2,638
Georgia	4,600	4,600	4,600	3,600	2,600	3,200	2,400	2,100	2,300
Illinois	......	......	......	5,500	3,000	3,875	......	......	3,045
Indiana	5,500	......	......	4,400	2,750	3,801	3,800	2,100	2,855
Iowa	6,000	6,000	6,000	6,500	3,700	4,500	3,500	2,750	3,087
Kansas	......	......	......	3,500	2,160	3,076	2,880	1,800	2,280
Kentucky	4,500	......	......	4,000	......	2,827	3,000	2,400	2,600
Louisiana	......	......	......	......	......	......	......	......	......
Maine	4,400	......	......	2,600	2,900	3,400	2,700	2,300	2,500
Michigan	7,500	......	......	6,000	4,000	4,554	3,900	2,500	3,635
Mississippi	......	......	......	3,600	2,750	3,500	3,600	2,750	3,175
Minnesota	6,000	......	......	5,500	3,000	3,600	3,250	2,400	2,900
Missouri	4,800	......	......	3,600	2,700	......	2,700	2,100	......
Nebraska	5,000	......	......	4,000	2,200	3,154	3,200	1,800	2,337
North Carolina	5,250	......	......	5,000	3,000	3,334	2,750	2,250	2,507
Ohio	6,000	......	......	6,000	3,500	4,250	......	......	......
Oklahoma	6,000	3,000	......	4,200	3,600	......	2,800	2,600	......
Tennessee	4,350	......	......	3,250	2,650	2,950	2,730	2,320	2,525
Tulane	......	......	......	......	......	......	......	......	......
Vanderbilt	4,200	4,200	4,200	4,200	3,000	3,700	3,000	2,500	2,700
Washington	4,750	4,400	4,475	4,600	3,000	3,986	3,400	2,500	3,055
Wisconsin	7,500	6,000	......	6,000	4,000	5,166	4,000	3,500	3,632
West Virginia	5,200	4,500	5,000	4,200	3,600	3,800	3,300	2,700	2,950
Virginia	5,000	5,000	5,000	4,500	3,000	3,700	3,500	1,875	2,650

Dean of the College of Arts at the University of Texas. Table A includes the salaries from the deans to the associate professors. Table B gives the salaries of the lower grades. Table C is furnished men by W. R. Long, auditor of the University of Texas. Table D is a partial table collected by the writer and is incomplete, but it is hoped to complete.

TABLE B

SALARIES, COLLEGE OF ARTS AND SCIENCES, 1920–21.

	Adj. Profs.			Instructors.		
	Max.	Min.	Av.	Max.	Min.	Av.
Texas	$3,000	$2,400	$2,747	$2,200	$1,800	$1,989
Alabama	2,250	1,600	2,100	1,800	1,000	1,500
Arkansas	2,500	2,100	2,340	2,000	1,600	1,967
California	2,900	2,700	2,800	2,400	1,800	2,100
Colorado	2,300	1,800	2,050	1,800	1,200	1,500
Cornell	......	......	......	2,100	1,200	1,479
Georgia	2,100	1,800	1,975	1,500	1,500	1,500
Illinois	......	......	2,692	......	......	1,523
Indiana	3,500	1,500	2,252	2,200	900	1,521
Iowa	3,500	2,200	2,555	2,600	1,200	1,850
Kansas	2,500	1,500	2,017	2,500	1,400	1,555
Kentucky	2,300	1,400	1,943	2,000	750	1,513
Louisiana	......	......	......	......	......	......
Maine	2,100	1,900	2,000	1,600	1,500	1,575
Michigan	3,400	2,500	2,725	2,400	1,500	1,823
Mississippi	2,400	1,800	2,000	2,000	1,500	1,750
Minnesota	3,250	2,000	2,446	2,400	1,500	2,000
Missouri	2,400	1,800	......	2,000	1,500	......
Nebraska	3,000	1,700	2,164	2,500	1,400	1,775
North Carolina	2,500	1,850	2,164	2,000	800	1,411
Ohio	3,500	2,300	2,750	2,500	1,400	2,000
Oklahoma	2,400	2,200	......	2,000	1,600	......
Tennessee	2,080	1,400	1,740	1,690	900	1,295
Tulane	......	......	......	......	......	......
Vanderbilt	2,500	2,200	2,300	2,000	1,500	1,700
Virginia	2,750	1,750	2,000	1,200	300	740
Washington	3,000	2,250	2,591	2,500	1,500	1,893
Wisconsin	3,500	2,250	2,842	2,200	1,500	1,829
West Virginia	2,700	2,100	2,500	2,100	1,200	1,800

TABLE C

TABLE OF MAXIMUM AND MINIMUM SALARIES PAID IN 1920 IN 10 STATE UNIVERSITIES.

	Professors.*		Assoc. Profs.		Asst. Profs.		Instructors.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Wisconsin	$8,500	$4,000	$4,500	$3,100	$3,800	$2,100	$3,000	$1,000
Michigan	10,000	4,000	5,000	3,500	5,000	2,500	3,000	1,500
Texas	5,000	4,250	4,000	3,250	3,000	2,250	2,200	1,800
Iowa	6,500	2,500	4,000	2,760	3,500	1,600	3,000	1,200
California	6,000	3,000	3,800	2,600	3,750	2,000	2,700	1,600
Illinois	6,000	3,000	3,900	2,700	3,500	2,200	3,000	1,200
Ohio	6,000	2,750	3,000	2,500	3,300	1,800	2,750	1,000
Washington	5,400	3,150	3,500	2,500	3,150	2,200	2,400	1,066
Indiana	5,500	2,750	4,000	2,100	3,500	1,500	2,200	800
Minnesota*	6,000	4,000	......	3,300	......	2,400	......	1,800

TABLE D

ENGINEERING SALARIES PAID IN 1920–21.

School.	Dean.	Profs.	Assoc. Profs.	Adj. or Asst.	Instr.
1. U. of Minn. . .	$8,000	$3,000 to $4,000	$2,750 to $3,000	$2,000 to $2,700	$1,800 to $2,400
2. Yale.	8,000	5,000–7,000	4,500	3,000–5,000	2,500
3. Harvard.	6,000–8,000	6,000–8,000	5,000–5,500	3,500–4,500	1,400 up
4. U. of Michi. . .	7,500 up	4,000 up	3,500 up	2,500 up	1,500 up
5. U. of Wis.	7,500	4,250–6,000	3,250–3,650	2,750–3,100	1,500–2,
6. Cornell.	7,500	3,500–5,000	. . . .	2,500–3,000	1,200–2,
7. U. of Penna. . .	7,000	4,575	. . . .	2,800	1,850
8. U. of Calif. . . .	6,500	4,500–6,000	3,000–4,500	2,700	1,800
9. Leland Stan. . .	. . . .	4,000–7,000	3,000–3,800	2,500–2,800	1,800–2, 5
10. U. of Iowa. . . .	6,000	3,700–5,000	3,000–3,500	2,500–3,000	1,750–2,100
11. U. Toronto . . .	6,000	4,500–5,500	3,500–4,300	2,700–3,450	1,800–2,024
12. U. of N. Y. . . .	. . . .	4,500–6,000	3,500 up	2,500 up	1,500 up 00
13. U. of Texas. . .	5,000	4,250–5,000	3,250–3,750	2,400–3,000	1,800–2,200
14. Geo. Wash. U.	5,000	2,700–3,500	. . . .	2,200–2,700	1,800–2,200
15. Case School . .	5,000	4,500	3,000	2,500	1,800–2,000
16. U. of Akron . .	5,000	3,600–4,200	. . . .	2,640–3,360	2,160–2,640
17. Worcester P. .	. . . .	3,000–5,000	. . . .	2,500–3,000	1,500–2,500
18. U. of Mo.	4,800	2,700–3,300	2,400–2,700	2,100–2,400	1,500–1,800
19. Tex. A. & M. .	4,500	3,250–3,600	2,400–2,750	2,000–2,400	1,650–2,000
20. Kans. Agri. . . .	4,500	3,400	2,450	2,075	1,775
21. U. of Nebr. . . .	4,500	3,600–3,800	2,500–3,000	1,800–2,100	1,800
22. U. of S. Dak. .	4,500	3,600	3,000	2,500	. . . .
23. Wash. Uni. . . .	4,500	3,500–4,750	2,800–3,500	2,100–2,800	1,400–2,100
24. U. of Okla. . . .	4,500	3,600	2,800	2,400	1,600
25. Ore. Agri.	4,500	3,800	3,000–3,600	2,500–3,000	1,800–2,400
26. Tufts Coll. . . .	4,500	4,000	3,000–3,500	2,500–3,000	1,500–2,000
27. Stevens In. . . .	. . . .	4,500	. . . .	3,000	1,000–1,800
28. U. of Wash. . .	4,400	4,400–3,500	3,300–2,700	2,650–2,200	2,250–1,750
29. U. of Maine . .	4,400	3,500	2,700	2,100	1,700
30. U. of Utah . . .	4,200	3,600	3,000	2,500	2,100
31. U. of Kans. . . .	4,000	2,900–3,500	2,400–2,800	2,000–2,300	1,600–1,800
32. Georgia T.	4,000	3,600	3,000	2,100–2,700	1,650–2,000
33. U. of Vermont	4,000	3,200	2,800	1,800–2,400	1,200–1,800
34. Marquette U. .	4,000	3,000	2,700	2,400	1,800–2,100
35. Clemson Coll .	4,000	2,800	2,250–2,500	2,000–2,250	1,400–1,800
36. Col. Mines . . .	4,000	4,000	2,200	2,700	1,500
37. Lafayette C. .	. . . .	4,000	3,000	2,500	1,800
38. Vanderbilt. . . .	3,000–4,000	3,000–4,000	2,500–3,000	2,000–2,500	2,000
39. Rose Poly.	4,000	3,000–3,500	2,500–2,850	2,000–2,250	1,500–1,800
40. U. of Col.	3,800	3,500	2,600	1,800–2,000	1,200–1,700
41. Toledo Uni. . .	. . . .	2,300–3,000	2,000–2,500	1,500–2,000	1,200–2,000

At present there are three kinds of men in our college faculty.

1. The old man and middle age man who hold on through love of the institution and on account of local ties.

2. Young men who do not have the desire or ambition to push matters and are willing to accept moderate salaries rather than get out in the world and fight from the shoulder.

3. Young men with red blood, vim and vigor, who will not stay long in the academic harness but who will get out into the conflict.

It is of the highest importance that the latter class be held if possible, because the future of the institution depends largely on them.

What is the solution?

REPORT OF COMMITTEE NO. 8, ADMISSIONS.

The 1896 report of the Committee on Entrance Requirements was made at the beginning of the work of standardization. That efforts toward standardization were timely is emphasized if we note that some engineering colleges required for entrance credits in each of the following subjects, as well as in those which we now consider necessary.

Arithmetic	Botany
Mensuration	Geology
Elementary mechanics	Introduction to Science
Drawing	Meteorology
Manual Training	Natural history
Local government	Physical geography
Local history	Physiology
Civil government	Zoölogy
Bookkeeping	Etymology
Logic	Latin elements in English
Economics	Spanish
Miln's "Realm of Nature"	Greek
Astronomy	

These subjects gradually disappeared, a unit measure of high school work was defined and the report of 1911 recommended as specific requirements:

Algebra, elementary	1 unit
Algebra, advanced	1 "
Geometry, plane	1 "
Geometry, solid	½ "
English	3 units
One other language	2 "
or Physics or chemistry	1 unit

This report also calls attention to the harmful effect of "browsing around" in high-school courses, an evil which is

still with us. The 1911 report names as subjects from which requirements and electives should be used for entrance to an engineering college:

Mathematics
- Algebra, elementary
- Algebra, advanced
- Geometry, plane
- Geometry, solid
- Trignometry, plane

Language
- English
- French
- German
- Spanish
- Latin

Science
- Physics
- Chemistry
- Botany
- Zoölogy
- Physical geography

History
- Ancient
- Modern European
- English
- American

General
- Manual training
  - Shop work
  - Mechanical drawing
  - Freehand drawing

The committee formulated outlines of courses in each of these subjects, indicative of its idea as to content and scope.

In 1916 summaries of the previous reports were made with quotations therefrom. The committee then presented and discussed the " New Plan " of Harvard, Yale and Princeton, requiring (1) certification as to a satisfactory 4-year high school course and (2) the passing of four examinations. Quoting—" The avowed purpose of the New Plan examinations is to reach out for the boy who has not been specially fitted for college, or to put it another way, to make the preparation for college less conventional and less subservient to tradition."

The " Chicago " plan admits students without examinations if they come from approved schools. But the retention of the school upon the approved list " will thereafter depend upon the records made by the students sent to the university from the schools." A definite list of fundamental subjects is given from which at least seven units must be offered.

Rather flexible rules apply to other units to a total of 15 required for entrance.

It is noteworthy that in the foregoing plans, " a candidate will be admitted without conditions or not at all."

In antithesis to these plans certain state legislatures have required that " graduates from any approved course of study in high schools of the state shall be entitled to admission to the freshman class of the university and other institutions." Undesirable as this is, it is not so disastrous as it might seem, for no restrictions attach as to how long the student may take in completing the four-year college course, with all of its prerequisites. The serious feature is that institutions operating under this rule must content themselves to give much preparatory work.

A perusal of literature available in 1921 from 88 engineering colleges and universities in the United States (see table), indicates that the Harvard and the Chicago plans have not been widely adopted. Very largely, accredited school lists have been established by university or state authorities and form the basis for entrance without examinations. The degree of control which the institution has in determining its own accredited list differs rather widely, but in general each college maintains its own list for its region. The appearance of several accrediting associations has introduced a factor which has helped very materially in standardizing methods of admission to colleges.

In general, therefore, students are now admitted by operation of one or more of the following records:

1. High school scholarship.
2. High school certification.
3. High school principal's estimate.
4. College entrance examinations in conventional subjects.

It is probably true that the requirements common to all colleges have approached as closely to a fixed list as is safe or desirable. It is now found that there is practical unanimity in requirements in English, algebra and plane

geometry; strong agreement in foreign language, science and history, partial agreement in solid geometry and trigonometry. Upon the other hand, only two institutions of those studied include in their requirements subjects not in these three groups, and they introduce only one additional subject each. Again, the manual arts are not prescribed by colleges altho they are accepted to a limited extent as electives. Commercial subjects are meeting the same passive opposition.

In the last five years the most pregnant developments have been two ideas, perhaps more or less closely related, which have not yet had time to impress themselves upon our methods of procedure. The first of these is the report issued by Dr. Mann, upon engineering education, in which he challenges the efficacy of the system of admission upon credits and suggests the substitution of a demand for proof of the abilities of the applicant. The great difficulty here lies in the lack of measures and standards of abilities. The second proposition suggests one possible method of attack of the problem of evaluation as raised in Dr. Mann's report. Intelligence tests are now being studied by many institutions in the hope that we may be able to gage their possibilities in connection with both admission to colleges and vocational guidance. It is too early to predict results but we may well be optimistic if we can but deliberate as well. Committee No. 22 of the Society for the Promotion of Engineering Education has been organized to coöperate in this investigation. When this work has progressed further, we shall probably elect to use one or more of the following methods of appraisal, in addition to or in conjunction with some of those listed above:

5. General intelligence test.
6. Personal history questionnaire.
7. Interest analysis.
8. An examination of capacity, which should involve the fundamental principles of the high school subjects applied to simple problems of professional interest.

PRELIMINARY REPORT OF COMMITTEE NO. 8.

	English.	Algebra.	Plane Geom.	Solid Geom.	Trigonometry.	Science.	Physics.	Chemistry.	Language.	History.	Other.	Elective.	Total.
Alabama Poly. Inst.	6	(Math. 6)					2	2		2		1	30
Brown Univ.	6	3	2	1			2	2	4	2		6	28
Calif. Inst. Tech.	6	4	2	1	1		2	2		2		10	30
Carnegie Inst. Tech.	6	3	2	1			2					16	30
Case Sch. Ap. Sci.	6	3	2	1			2	2	4M			10	30
Clemson Coll.	6	3	2				2			4		13	30
Coll. City of N. Y.	6	2	2						10	2		8	30
Colorado Coll.	6	3	2	1			2	2	4	4		6	30
Columbia Univ.	(3 years of college work; Chem., Math. Mech. Drwg.)												
Cornell Univ.	6	4	2	1	1				6	2		8	30
Dartmouth Coll.	6	3	2			2			6M	2		8	29
George Wash. Univ.	6	4	2	1	1		2	2	4M			8	30
Georgia Sch. Tech.	6	4	2	1			2			2		13	30
Harvard Univ.	6	4	2			2			6M	2		8	30
Iowa State Coll.	6	3	2	1						2		16	30
Johns Hopkins Univ.	6	3	2						8	2		9	30
Kansas St. Ag. Coll.	6	3	2	1			2					16	30
Lafayette Coll.	6	3	2	1		2			4	2		9	29
Lehigh Univ.	6	3	2	1	1				4M	2		9	28
Louisiana St. Univ.	6	3	2						4	2		15	32
Mass. Agr. Coll.	6	3	2						4			14	29
Mass. Inst. Tech.	8	4	3	1	1		2	(2)	6–8	2			
Mich. Ag. Coll.	6	3	2	1			2					16	30
Mich. Coll. Mines	6	3	2				2		4			13	30
Miss. A. & M. Coll.	6	2	2							2		16	28
Montana Sch. Mines	6	3	2	1			2					16	30
New Hampshire Coll.	6	3	2	1		2				2		14	30
New Mex. Coll. A. & M.	6	3	2	1			2		4	2		10	30
New York Univ.	6	3	2	1	1		2		4			11	30
N. Dakota Ag. Coll.	6	3	2	1								18	30
Ohio Northern Univ.	6	2	2	1		2			4	2		11	30
Ohio State Univ.	6	3	2	1			2		4			12	30
Okla. A. & M. Coll.	6	3	2	1			2		2			14	30
Oregon Ag. Coll.	6	3	2	1			2					16	30
Penn. State Coll.	6	3	2	1		4			4	2		8	30
Poly. Inst. Brooklyn	6	3	2	1	1		2	2	6	2		5	30
Princeton Univ.	6	4	2	1	1		(2)	(2)	8			6	30
Purdue Univ.	6	3	2	1		2				2		14	30
Rensselaer Poly. Inst.	6	3	2	1		2			4	2		8	28
R. I. State College	6	3	2	1			2		4	2		8	28
Rose Poly. Inst.	6	3	2	1					4	2		14	32
Stanford Univ.	6	3	2	1	1	2			4	2		9	30
Stevens Inst. Tech.	6	3	2	1	1		2	2	4	2		6	29
Syracuse Univ	6	3	2	1					6			12	30
Tufts College	6	3	2						4	2		13	30
Tulane Univ. of La.	6	3	2	1		4			4			10	30
Union Univ.	6	3	2			2			4M	2		11	30

PRELIMINARY REPORT OF COMMITTEE NO. 8.

	English.	Algebra.	Plane Geom.	Solid Geom.	Trigonometry.	Science.	Physics.	Chemistry.	Language.	History.	Other.	Elective.	Total.
Univ. California	4	3	2		1		2	2			2	14	30
Univ. Cincinnati	6	2	2	1					4	2		15	32
Univ. Colorado	6	(Math. 6)					2		4	4		8	30
Univ. Florida	6	(Math. 8)				2	2			2		12	32
Univ. Georgia	6	(Math. 5)							4M	4		11	30
Univ. Idaho	6	3	2	1		4					4	10	30
Univ. Illinois	6	3	2	1		2						16	30
Univ. Iowa	6	3	2	1						2		16	30
Univ. Kansas	6	3	2	1			2					16	30
Univ. Kentucky	6	2	2									20	30
Univ. Maine	6	4	2	1		2			4	2		8	29
Univ. Maryland	6	3	2	1		2				2		14	30
Univ. Michigan	6	3	2	1	(1)		2	(2)	4	2	(2)	6–7	30
Univ. Minnesota	6–8	2	2						4–0			16–18	30
Univ. Mississippi	6	2	2	1						4		15	30
Univ. Missouri	6	2							4			18	30
Univ. Montana	6	3	2	1			2					16	30
Univ. Nebraska	6	3	2	1			2	(2)	4	2		10	30
Univ. Nevada	6	3	2	1		2	2			2		12	30
Univ. New Mexico	6	2	2									20	30
Univ. North Dakota	6	3	2	1		2						16	30
Univ. Notre Dame	6	3	2	1			2	2	4	2		8	30
Univ. Oklahoma	6	3	2	1		2			4			12	30
Univ. Oregon	6	3	2	1		2			4	2		10	30
Univ. Pennsylvania	6	3	2	1	1		2		4	2		9	30
Univ. Pittsburgh	6	3	2	1			2		4	2		10	30
Univ. South Dakota	6	3	2	1			2			4		12	30
Univ. Southern Calif.	4	4	2	1	1		2	2	4	2		8	30
Univ. Tennessee	6	3	2	1		4						14	30
Univ. Texas	6	4	2						4	4		10	30
Univ. Utah	6	2	2									20	30
Univ. Vermont	6	3	2	1		2			4	2		10	30
Univ. Virginia	6	4	2	1	1					2		14	30
Univ. Washington	6	3	2	1			2					16	30
Univ. Wisconsin	6–4	3	2			(2)			(2)	(2)		17	30
Univ. Wyoming	6	3	2	1		2			4	4		8	30
Virginia Mil. Inst.	4	2	2							4		16	28
Virginia Poly. Inst.	6	3	2	1		2				2		16	32
Washington Univ.	6	3	2	1								18	30
Worcester Poly. Inst.	6	4	2	1		2			8	2		4	29
Yale	6	4	2			2			8	2		6	30

Another growing influence in matters governing admission to colleges is the recent movement toward the organization of accrediting associations already mentioned. The success of 26 years of work by this type of organization in the middle west (North Central Association of Colleges and Secondary Schools) has led to the development of interstate associations in both the northwest and the south. The three associations now existing comprise 34 states. The New England district is organizing for this same purpose, as is also the Middle Atlantic section. When these movements are completed, all states in the Union except California will be included within their membership. It is predicted that within the next two years a National Accrediting Association will be in operation, and this committee heartily endorses its organization.

REPORT OF COMMITTEE NO. 14, BUSINESS TRAINING.

Under this caption one would ordinarily include two general plans, or programs, of study for students who intend to enter the engineering field.

First. One or more courses of study, to be taken by *all* engineering students, these courses being intended to equip the student to understand the purely business problems incident to all engineering work; and

Second. A curriculum, usually four years in length, designed to prepare the student to enter upon a business career immediately after graduation. Such a curriculum usually includes a thorough preparation in the fundamental sciences and those technical courses which are common to all engineering fields of work. Upon such courses as a foundation there is built a broad training in strictly commercial and economic subjects.

This second program is one which is offered by a number of engineering schools under various titles and seems to be growing in favor.

However, the Committee interprets its assignment to refer rather to the first of the two headings and it will therefore confine its report to suggestions with reference to courses rightfully belonging in every engineering curriculum and designed to acquaint the student with those business and legal principles which he is sure to need if he is to become a successful practicing engineer.

During recent years engineering teachers have shown more and more interest in these non-technical courses and few there are who are not willing to accede to the claim of the selves, that no school should graduate engineers who have not practicing engineer and the demand of the students them-

been given an opportunity to prepare themselves for everyday business practice.

Granted, then, that this training is desirable, and even necessary, the next and most important consideration is what subjects shall be chosen to best impart the desired training and information.

The introduction of new subjects will inevitably displace some of the strictly technical work formerly given the student, but just what this material so displaced shall be, may safely be left to the individual or faculties responsible for the curricula affected.

Under the heading "Curricula Suggestions" a conference committee on "Commercial Engineering" called by the U. S. Commissioner of Education on June 23–24, 1919, approved the following:

"First, That a minimum number of hours in business training, to be determined by the committee, be required in all engineering courses. In respect to this suggestion, it was recommended at the Washington Committee Conference that from 12 to 18 semester hours be required in all engineering courses in the following subjects: General Economics, Cost Accounting, Business Organization, and Business Law.

"Second, That a curriculum, providing for a minimum of 15 to 30 units in business economics, be incorporated in all engineering courses and offered on an elective basis. In respect to this suggestion the Washington Committee Conference recommended that electives be encouraged in connection with all engineering courses in the following subjects: Labor and Employment Problems; Statistics; Corporation Management and Finance; Political Science; Marketing, including Advertising and Salesmanship; Psychology; Scientific Management; and Transportation. It was further recommended that economic phases of engineering subjects be emphasized wherever possible in engineering instruction." *

* See Bulletin U. S. Bureau of Education, 1919, No. 58, Commercial Engineering—Report of a Conference on Business Training for Engineers and Engineering Training for Students of Business—held in Washington, D. C., June 23–24, 1919, prepared by Glen Levin Swiggett.

These recommendations contain at least the "gist" of all subsequent discussions and changes of curricula as carried out by engineering faculties.

This requirement of 12 to 18 semester hours in a four-year curriculum is a modest one and may be considered as a figure which engineering teachers could be prevailed upon to grant, rather than the amount of time needed in order to properly present the subjects named. Such time, also, may properly include advanced work in English. Care must be observed then in making such arrangement, technical courses themselves are not diluted to the extent of being non-effective.

One fundamental question arises in connection with the adoption of any of these courses, namely, that they shall be discussed with the student not from an abstract, or detached, point of view, but that the material presented and the deductions drawn therefrom must possess a very real significance as related to the engineering and everyday experiences of the student. Certain members of the engineering staff, specially qualified, may, therefore, give some of these courses, particularly those relating to organization and management. English may be made attractive to engineering students when the subject matter for themes, etc., is carefully selected; these should relate to scientific subjects and be recommended, where coöperation is possible, by both English and engineering teachers. Similarly we believe that economics, business organization, cost accounting, etc., will make their appeal to embryo engineers when properly motivated by topics and illustrations selected from the fields of engineering practice.

Engineering teachers are following to a marked degree the recommendation "that economic phases of engineering subjects be emphasized wherever possible in engineering instruction" and it is equally important that engineering aspects of economic questions be brought out as much as possible, if we expect to "put across" the suggested courses to engineering students. It may be wiser to limit the number of required subjects and place in the elective group all those subjects which are desirable as well as attractive to the average student.

Again the possibilities as to courses to be offered will vary among engineering schools in accordance with the size and make-up of the faculties responsible for instruction in economic and business subjects.

If we are willing to accept Dr. Jenks' definition of Economics as "The Science of Business," we may well require this subject as a prerequisite for all other business courses. The recommendation made by the Committee on Economics, at the time of the annual meeting in 1917, should be remembered in this connection, viz., that "a satisfactory course in the principles of economics will require at least a full year of three hours per week." It may not be essential to acquiring a knowledge of accounting, management, contracts, etc., but certainly a student has acquired a broader point of view and better "tools" with which to work, if he has completed a broad course in economics before taking up the more specialized courses.

MORRIS KNOWLES,
Chairman.

REPORT OF COMMITTEE NO. 15, CIVIL ENGINEERING.

The status of highway improvement throughout the United States and of highway engineering courses in American universities, the general and technical education considered essential and desirable for men preparing for the field of highway engineering, and the number of graduates in civil engineering annually required to fill positions in highway departments of the nation, states, counties and municipalities were comprehensively discussed at the Conference on Highway and Highway Transport Engineering Education held in Washington on May 14–15, 1920, at the call of the U. S. Commissioner of Education, P. P. Claxton.

A report* of this conference was presented at the 1920 meeting of this Society, and the complete proceedings have been published in a report entitled "Education for Highway Engineering and Highway Transport," being Bulletin No. 42, 1920, Bureau of Education, U. S. Dept. of the Interior. As this information is readily available to the members of this Society your Committee does not consider it expedient to embody in this report a long, introductory statement relative to subjects which were thoroughly discussed at the conference and relative to which no new conclusions of value are warranted based on developments during the past year.

The committee, therefore, will confine this report to brief recommendations relative to courses in highway engineering which should be given under the supervision of Civil Engineering Departments.

Your Committee submits the following recommendations for your consideration:

* PROCEEDINGS, Vol. XXVIII, pages 269 to 275.

1. In four-year civil engineering curricula without technical electives, there should be included a course in the fundamentals of highway engineering aggregating three hours per week throughout one collegiate year.

2. In four-year civil engineering courses with options, there should be included a required two or three hour semester course or a course aggregating thirty to fifty hours in the fundamentals of highway engineering, and optional courses aggregating six to nine hours a week for one semester which would include courses in the theory and economics of highway improvements, highway design and highway laboratory.

3. In not less than ten universities, located in different geographical sections of the United States, there should be offered short period advanced courses covering all phases of highway engineering, These advanced specialized courses should be designed primarily for men who have taken a first degree, who have acquired a knowledge of the fundamental, principles upon which such advanced courses are based, and who have had a certain amount of experience in highway engineering. It is evident that such courses should be given under such conditions that it will be practicable for engineers and others engaged in highway engineering to take advantage of the opportunities offered. Such courses, given in a concentrated form in short periods of from two or three weeks during the winter months, constitute the most efficient method of meeting the demand of practicing engineers for advanced technical education in highway engineering. Graduate courses of this type were fully explained in a paper entitled "Graduate Courses for Practicing Engineers" presented before the Society in 1916.

4. One engineering institution in each state should conduct, sometime during the winter months, a highway engineering conference of about one week in length, for the discussion of the highway engineering problems of the state by the engineers and officials of the state, county and municipal highway departments.

If the Committee is authorized to serve for another year, it will present a final report in 1922 which will embody recommendations pertaining to highway engineering courses in fifth year curricula, highway engineering research, and the introduction of fundamental courses in transportation in civil engineering curricula.

A. H. BLANCHARD,
Chairman.

REPORT OF COMMITTEE NO. 16, MECHANICAL ENGINEERING.

Production engineering is generally accepted in manufacturing establishments to denote the planning of methods of manufacture and the design of necessary auxiliary equipment. The operating proper of production is not usually classed as production engineering.

The above limitation in meaning has been a gradual growth and has no *à priori* right. Your committee believes that the exclusion of the operating field is an undesirable state of affairs and that engineering educators should endeaver to change this condition.

Dr. C. R. Mann draws attention, in his Study of Engineering Education, to this neglect of the operating field and the Chairman of your Committee has discussed this feature at length in a article entitled, "The Scarcity of the College Trained Engineer in Production," published in the Society's Bulletin No. 6, Vol. 11.

Production work, either from a standpoint of design or that of operating differs from other engineering design in emphasizing more markedly the importance of coördination and coöperation; also, due to the continuous stream of events, scope for judgment, based on statistical analysis and a semiconscious use of the mathematics of chance, is much more pronounced.

It is generally recognized that all leading engineering schools are modifying their curricula to develop more in the direction of administrative engineering. In fact there has been, and is, an incessant pressure in this direction. This movement tends partially to overcome the barrier between engineering education and production.

Your committee has made an investigation of the curricula of various schools, some of the more important features of which are here given.

Columbia University has gone most vigorously into the field of production engineering and offers a six-year course leading to M.Sc. in Industrial Engineering. In this, fourteen courses are listed, specifically long production lines, two of which cover eight weeks service in a manufacturing establishment under faculty supervision.

Massachusetts Institute of Technology offers a full course leading to a degree in engineering administration. In this the student may specialize either in civil, mechanical or electrical engineering.

Harvard University has started a five-year course in engineering administration with options in civil, mechanical and electrical engineering. This is conducted by the Harvard Engineering School and the Harvard Graduate School of Business Administration.

The University of Illinois has eight courses in the field of production engineering and six of these are required of all students in mechanical engineering.

The Pennsylvania State College gives a course in industrial engineering in which are ten courses in the field of production engineering.

The University of Cincinnati has two courses in production engineering. These are given in the regular course in mechanical engineering.

The University of Nebraska offers a degree of B.Sc. in commercial engineering for a fifth year's work. In this, six courses are offered in the field of production engineering.

Purdue University offers six courses in the field of production engineering. These are given in the industrial management group of the regular course in mechanical engineering and lay emphasis more on the technical side.

The University of Michigan offers three courses in the field of production engineering. One of these is required of all students in mechanical engineering and in electrical engineering. The others are in a group option in industrial engineering which in turn is a part of the mechanical engineering course.

Cornell University offers six courses in production engineering to students taking the industrial engineering group of the course leading to M.E.

Yale University offers four courses in the field of production engineering to students in mechanical engineering and has a separate course in administrative engineering.

Brown University has an elective course in manufacturing methods.

The University of Pittsburgh gives one course in process of manufacture.

The Rose Polytechnic Institute gives ten lectures on shop equipment and factory management for all students in mechanical and in electrical engineering.

The Kansas State Agricultural College offers three courses in Production Engineering, two of which are required of Mechanical Engineering Students, the third being elective.

If engineers are diverted into administrative channels, then presumably the conditions pointed out by Dr. Mann, viz., that under 5 per cent. of production managers are college graduates, will be modified. However, your committee wishes to point out that the present educational tendency savors too much of a gentlemen apprenticeship to a big position, or to put it otherwise, that the training is not so well fitted as it might be for a more uniformly graded avenue of progress.

Probably nowhere is administrative ability given the opportunity to develop in easy stages so flexibly as in a production operating department. Your committee believes therefore, that most students directed towards administrative positions in manufacturing establishments should progress *through* the production department, starting probably as a foreman's assistant or even as an operator. It is a well-known fact that the majority of production managers do so develop. This point of view should be kept in mind in modifying curricula.

Recognizing that not all students trained in administrative engineering will become company presidents, greater emphasis should be placed on instruction of material useful to the student when occupying the lower rungs of the ladder of success. This is particularly true when we consider that the majority of the student body permanently occupy the lower rungs. A greater importance should be given to the methods of production; specifically a student should be taught:

1. What operations are required to make a given product.
2. What equipment and tools are necessary for these operations.
3. How long an operation should take.
4. What constitutes a typical equipment for a definite manufacturing program.
5. How far from assembly the various components must be started in order to secure uniform employment of equipment and men.

Your committee also points out that the divergence between the ideal training for a production man and our present training in mechanical engineering is much greater than that between the present training in civil, mechanical and electrical engineering. Because of this it is believed to be illogical to regard production engineering educationally as an off-shoot of mechanical engineering. The arguments for this situation are of course similar to those for the administrative engineer. Many institutions still regard administrative engineering as an off-shoot of mechanical engineering. The Massachusetts Institute of Technology however gives a separate degree in engineering administration in which course the students can specialize either in civil, mechanical or electrical lines. Similarly Columbia University and the Pennsylvania State College give a separate degree in industrial engineering.

In view of the wide divergence between the ideal training of a production engineer and that of a mechanical engineer, it is believed that regarding the former as an educational offshoot of the latter is liable to retard its growth. In fact it is a debatable question whether the desired training is not best given as a combined economics and engineering course.

It is believed that more shop work should be given to future production men than is at present the case; also that this shop work should deal with actual production methods.

A very definite tendency exists in this direction in many engineering colleges. The University of Illinois is manufacturing, using quantity production methods, a gas engine. The

State College of Kansas is manufacturing vertical filing cases in their wood shop and a small lathe and gas engine in the machine shop. The Pennsylvania State College manufactures a line of cedar chests, desks with pedestals interchangeable for drawers or vertical files and card index drawers and book shelves, employing bills of materials, material and work tickets, a control board and dispatching system in connection with the work.

The University of Michigan is manufacturing two small articles, the more complicated consisting of only eleven total parts, involving in all about forty manufacturing operations. At the latter institution it is believed that the experiment is unique in educational history, as they are producing over 200 completed units per half-day period. This introduces much more than the technique of production; it introduces the trials and troubles of operating. In fact, these troubles are accentuated more than in a commercial establishment, because not only must stock be specifically circulated in its varying condition but so must each operator. At a later date a complete report of this experiment will be given to your Society.

In consequence of the point of view expressed in this report and in view of the increasing tendency for a more and more quantity production civilization, it is respectfully suggested that a committee on quantity production engineering be established as a permanent institution of this Society. This is desirable, both from the point of view expressed in this report and also because mechanical engineering would not otherwise receive the attention it merits in its many branches or else production engineering would have to be omitted for several years at a time.

J. Airey,
Chairman.

REPORT OF COMMITTEE NO. 17, ELECTRICAL ENGINEERING.

The problems of greatest interest in electrical engineering during the past year have been the following:

I. The general increase in registration of students.

Is this a permanent condition, for which increased permanent staff and faculties should be provided, or should it be looked upon as a more or less temporary situation which is likely soon to revert to normal or nearly normal numbers of enrolled students? Although it is generally believed that a permanent increase will obtain since the demand for graduates is in generall still in excess of the supply, yet a feeling persists that the present rate of increase will not be maintained indefinitely. In several cases steps are being taken to provide a higher quality, with limited numbers, by introducing more strict entrance requirements.

Many students, although passing entrance requirements, seem to have had a wider scope of previous training and practical experience, which with the increased numbers makes more difficult their training in curricula and classes prescribed for the average student. Is it practical to sectionalize upon a basis of previously indicated ability? Such a plan might require the weaker sections to pass the minimum specified for graduation and the stronger sections proceed to more advanced work in a particular course for which they may or may not receive additional credit? Discussion by those having had experience with student sections based upon previous grades is invited.

II. With the increased tendency toward the establishment of engineering experiment stations and the development of research opportunities, the question has been raised: "How vital to teaching is research?" This very broad question, involving as it does the continuation of the research type of

thesis whose existence is unfortunately doomed at many institutions, may not be discussed at length during this meeting. It might well form the subject of important papers and discussions in the *Bulletin* during the year.

III. How may the growth of an instructor be best estimated? This is particularly important in institutions in which nominations for appointment to the faculty are made by a committee of the faculty itself. In our institution where several sections of students are necessarily instructed in one subject and where the advantages of having theory and laboratory taught to the same group of students by the same instructor are recognized, several instructors may be needed for each subject in the curriculum. Such a condition offers more opportunity for studying the growth and effectiveness of the individual instructor than the old plan. The different reactions upon different groups of students, studying the same subject matter, are quite apparent.

IV. There seems to be a renewed interest in coöperation with industry. Many of those who believe that the period of exchange between the college and industry has been too short in the earlier coöperative courses are now requiring a year or at least a summer vacation in directed industrial experience before the degree is granted. This form of coöperative course is open to those institutions not located in industrial centers. Is this considered a desirable change?

V. Electrical engineering students are being approached for employment, to an increasing extent, by representatives of large industrial and public utility corporations. This is to be encouraged as such lectures tend to correlate class-room work with engineering practice and the conferences involved with managers offer valuable educational experience to the student. Since, however, it is understood that the Association of Corporation Schools has a committee working upon this problem in the interest of further standardization of methods of employment, it is recommended that a similar committee of the S. P. E. E. be appointed to represent the educational institutions.

VI. The technical press has recently given considerable attention to the importance of recruiting more technically trained men for the electric railway field. There seems to be a tendency at present for a large percentage of electrical graduates to enter the employ of the telephone and telegraph companies. Although this is an excellent outlet for many men, care should be taken to keep all branches of the profession proportionately active with properly trained graduates from our technical institutions.

C. F. HARDING,
Chairman.

REPORT OF PROGRESS OF COMMITTEE NO. 20, STANDARDIZATION OF TECHNICAL NOMENCLATURE.

For some years the Committee on Standarization of Technical Nomenclature of the Society for the Promotion of Engineering Education has been coöperating with committees from various engineering societies. The work on symbols was carried on actively before the war and resulted in the adoption by our Society of a list of symbols for mechanics and hydraulics in June, 1918.

Since that time the Committee has been considering symbols relating to heat engineering, but pressure of other duties has prevented much work on the part of the chairman. However, one of the members of our committee, Professor W. D. Ennis, who happens also to be chairman of the Committee on Technical Nomenclature of the American Society of Mechanical Engineers, has taken up the matter actively and it is by his courtesy that our committee is enabled to present his work and that of his associates as a report of progress.

Symbols in heat engineering are used more by mechanical engineers than by others and therefore mechanical engineers should have the right of way in the determination of the symbols in heat engineering. The preliminary report which follows is presented merely as a report of progress. Such comments as occur to members should be sent either to the undersigned or directly to Professor Ennis at 132 Nassau Street, New York City. Members of the Society having any interest in the symbols are most cordially urged to communicate with the writer or with Professor Ennis, for the reason that the work of the Committee of the American Society of Mechanical Engineers will doubtless in time be adopted by the Society for the Promotion of Engineering Education as far as symbols

for heat engineering go and controversy in the future may possibly be averted by frank expression of opinion now.

No serious exception can be taken to the fact that several of the symbols suggested in the preliminary report are the same symbols that are used for other concepts in the list of symbols already adopted for mechanics and hydraulics. It has long been clear that some of the letters and characters available would have to be used several times. This seems unavoidable when one considers the tremendous number of concepts and the small number of available characters. The use of the same symbol for a number of concepts will not lead to as much confusion as might be imagined. It is not often that concepts used in connection with heat engineering will appear in the same equation as the concepts used in mechanics and hydraulics.

It should be emphasized that the report which follows is not offered for adoption or for approval, but for comment and discussion.

JOHN T. FAIG,
Chairman.

TENTATIVE DRAFT OF PRELIMINARY REPORT, COMMITTEE ON TECHNICAL NOMENCLATURE, AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(Joint committee appointed July 1917, coöperating with a Committee of the Society for the Promotion of Engineering Education to investigate the Systematizing or Standardizing of Technical Nomenclature.)

1. The concepts or quantities for which symbols are most commonly used are, for a liquid or for its saturated or superheated vapor,

heat content,
temperature,
pressure,
volume,
entropy.

In addition, the following are commonly symbolized:
specific heat of superheated vapor at constant pressure,
mechanical equivalent of heat (778),
dryness (saturated vapor),
latent heat of vaporization (rarely that of fusion),
entropy of vaporization,
internal and external portions of the latent heat of vaporization,
ratio of specific heats of gases,
specific heats at constant pressure and at constant volume (gases).

Less commonly used symbols are those for
reciprocal of the mechanical equivalent of heat,
density,
absolute temperature.

2. As the result of a few preliminary letters and some oral discussion, the following principles seem to command rather general (though not universal) assent:

Avoid the use of Greek letters.
Do not attempt dimensional symbolism.

3. The standardization most needed is that which relates to symbols for properties of liquids and their vapors—particularly water. There are three physical conditions to be distinguished: liquid, saturated vapor (wet or dry) and superheated vapor. It is natural to use small and capital letters for two of these conditions: as h, H; t, T; v, V; n, N; for liquid and saturated vapor. The third condition must then be designated (unless by a different letter) by either a prime or a subscript.

Primes are not likely to be confused with exponents, because the latter are rarely used in heat engineering. The chief objection to them is one of typography. They are apt to break off or slip out.

Subscripts are objectionable because subscripts are also needed to refer to state points. Thus if N_1 denotes entropy of superheated steam, we might have to write $(N_1)b$. Both are

awkward forms and do not sound well when enunciated verbally.

4. Absolute temperature could be designated by $t + 460$, $T + 460$, etc., and no special symbol is imperatively necessary, although many writers use t for Fahrenheit and T for absolute.

5. Present usage seems to indicate maximum popularity for the following: C_p, J, p, t, h, L, or r, H, v (with primes or subscripts). For other quantities there is no uniformity of symbolism.

By using the following, there would be no departure from generally accepted usage:

heat content .... hHH^1
temperature .... $(t = T)\, T^1$
pressure .... p
volume .... vVV^1
entropy .... nNN^1 (It is true that n is often used as the polytropic exponent)
mech. equiv. .... J
its reciprocal .... A
dryness .... x or q (preferably the latter)
latent heat of vaporization ... $L = H—h$
entropy of vaporization ...... $N—n$ (no single symbol?)*
internal latent heat .... r (implies using L for total latent heat)
ratio of specific heats .... y (suggests a former Greek symbol)
specific heat at constant pressure .... C_p
specific heat at constant volume .... C_p

* There is perhaps a real need for a single symbol. The entropy of a wet vapor would be

$$n + q \ (N - n) \ = qN + n \ (l - q).$$

If for $(N—n)$ we had a single symbol, l (though this might be useful for latent heat of fusion) there would result the simpler form $n + ql$.

6. General discussion is invited. Letters should be addressed to W. D. Ennis, Chairman, 132 Nassau Street, New York City.

(Signed) For the Committee (of the A. S. M. E.),

W. D. Ennis,
F. L. Beers.

REPORT OF THE COMMITTEE ON ENGINEERING EXPERIMENT STATION LEGISLATION.

For a number of years efforts have been made by institutions and private individuals to induce Congress to establish engineering experiment stations and to appropriate money for their support.

Several bills have been introduced to carry out the different suggestions. One or more of these bills contained a provision that the engineering experiment stations should be located at the Land-Grant Colleges. A bill known as the " Smith Bill " provided

" That the State Legislature of each State is hereby authorized to designate and appoint that institution of its respective State which is best equipped and organized to conduct the work under this Act; provided, however, that in a State having at the Land-Grant College facilities for conducting the work provided for by this Act approximately equal to those of other institutions in that State, the Land-Grant College shall be designated as the location of the proposed station."

I believe that the general form of these bills was acceptable to the state universities but they proposed that the engineering experiment station should be located at the state universities rather than at the land-grant colleges, where both types of institutions existed in a given state.

A bill proposed by some of the non-land-grant colleges provided

" That the Secretary of Commerce is hereby empowered and directed to undertake in the manner hereinafter provided thru institutions of learning and other agencies for research, existing from time to time in the several states and territories, including Porto Rico, the Virgin Islands, and the District of Columbia, commercial and industrial investigations and researches, including among other things, those having to do

with the engineering, chemical, physical and economic problems connected with water supply, sewage treatment and disposal, disposal of urban and industrial wastes, flood protection, drainage and irrigation of lands, transportation of property and persons on land and water and thru the air, public lighting and heating, the development and transmission of power, the development and improvement of processes for the manufacture of materials useful to the people of the United States or to the people of any state or territory thereof, the development of marine architecture, and any other engineering or scientific problems bearing directly on the various industries and occupations or the welfare of the people of the United States or any particular state or territory;"

Section 2 of this bill provided:

"When any proposed work of research, compilation or investigation is referred to the Secretary of Commerce, by any individual, organization, or institution as desirable to be done, the Secretary of Commerce shall immediately refer the matter to the Executive Board of the National Research Council established under the National Charter of the National Academy of Science, which Executive Board shall make or cause to be made such investigations as may in its judgment be necessary to enable it to determine the novelty, need or desirability of the proposed work, and shall determine from such investigation whether or not such proposed work is new, now needful, desirable and justifiable, and shall report its findings to the Secretary of Commerce. If the said Executive Board shall find the proposed work to be new, needful, desirable and justifiable, the Secretary of Commerce shall authorize the work to be done under the supervision of the said Executive Board and shall provide for its performance out of funds available as hereinafter provided."

It is evident from the above quotations that there is no unanimity of opinion among engineers in regard to the way in which federal aid shall be used. As some of the members of this Society are connected with land-grant colleges and some are connected with state universities, and as there are many who are not connected with either of these types of institution, it seemed desirable to the committee to ask for a full discussion of this matter at the last meeting of the Society

held in Ann Arbor. At this meeting the following action was taken:

"*First:* That it is the sense and opinion of this meeting that there is a great need for engineering experimentation and research and that we favor Federal and State aid for experimentation and research.

"*Resolved:* That it is the sense of this meeting of the Society for the Promotion of Engineering Education that the committee on engineering experimentation proceed with its study of plans for the furtherance of engineering investigation and research and that it endeavor to harmonize the differences of the existing plans for this purpose, if possible, or, if this be found impracticable, that it recommend some plan of its own for consideration by this Society at a future meeting."

This resolution seems to your committee to have been a very wise one because correspondence and discussion with some members of Congress and with educational agencies in Washington seem to indicate that no bill granting federal aid to engineering research will receive the sanction of Congress unless all of the interests are united. So far as your Committee has been able to ascertain, all of the several interests except the land-grant colleges are perfectly willing to give up for the common interest any particular features which they have heretofore favored and to accept any compromise measures which may result in some form of Federal aid. The land-grant colleges in the past have insisted upon a bill which would make over to them all the money available for research and have refused to sanction any effort to bring the different interests together. After the passage of the above resolution and in accordance with the idea expressed therein, your committee entered into correspondence with the officers of the Asssociation of the Land-Grant Colleges for the purpose of finding out whether they would be willing to modify their plans in such a way as to unite with the other friends of federal aid for research in formulating a plan which might be satisfactory to all parties concerned.

The following letter was received from President Riggs, of Clemson Agricultural College, under date of April 23, 1921:

"*Dear President Howe:* At the recent meeting of the executive committee no change was made in the policy of the Land-Grant College Association to press their bill for engineering experiment stations in its original form. The committee, representing the sentiment of the Association, is opposed to any compromise which will put the engineering experiment stations anywhere than at the Land-Grant Colleges."

Your committee has, therefore, carried out the first suggestion in the resolution mentioned above and has endeavored to harmonize the various interests. The letter from President Riggs shows that this endeavor has been unsuccessful.

In studying the second part of the resolution—namely, to recommend some plan of its own for consideration by the Society at a future meeting, your committee has taken into consideration a number of matters which would seem to bear upon this subject.

First. Correspondence with those who know something about the methods of legislation.

A few letters have been written to persons who have some knowledge regarding the possibility of securing Congressional action on a subject of this kind at the present session of Congress. It is the opinion of former Senator Burton, of Ohio, now a representative in Congress, that it will be utterly impossible at this time to pass any new legislation carrying with it a grant of funds.

Dr. S. P. Capen, Director of the American Council on Education, in response to a letter from the committee, expressed the opinion that a special education bill such as a bill for engineering experiment stations would not stand much chance in the present Congress as there are now before Congress two comprehensive pieces of legislation. These are a bill to create a department of public welfare which will include many kinds of educational work, and a bill creating a department of education. Dr. Capen thinks that the members

of Congress who are interested in any form of education are connected more or less closely to one or the other of these bills and that it will be impossible to consider any other form of educational legislation at the present time.

Several members of the Society have expressed the view that it would be unwise to present to the present Congress any bill which might be drawn up by this Society. There is a strong feeling on the part of many of those interested in Federal aid for research and those who have a knowledge of legislation that it will be impossible to secure any action until all those who have hitherto taken an interest in this matter can unite and express their views in a single bill which can be presented without oppositions.

The committee, after careful discussion through correspondence, of the views expressed above has reached the following conclusions:

First—That it is exceedingly desirable that federal aid shall be given for the furtherance of engineering research and that this society should stand ready at all times to do what it can to secure such federal aid.

Second—That federal aid should not be given exclusively to any one class of institutions but should either be used to establish one or more great engineering research laboratories similar to the Bureau of Standards, or that grants of money should be made to institutions and societies peculiarly fitted for undertaking research or that both of these plans should be followed through the promotion of a suitably organized bureau.

Third—That it is extremely unwise at this time for this Society to draw up a bill of its own, because (*a*) Congress will probably not pass any legislation on the subject at the present time, and (*b*) because such a bill would undoubtedly meet with opposition from certain friends of federal aid, while it is the desire of your committee, and, we believe, the desire of the Society, to bring together in a friendly and powerful way all of those forces which are interested in this matter.

Fourth—That the Society should continue to have a committee on this subject and that the Committee should keep watch of legislation and the trend of matters in Washington and should be ready whenever the proper time comes, either to introduce or approve a bill which will contain very broad provisions for federal aid and a wise distribution of such aid either directly or indirectly to such institutions as are able to take advantage of it.

CHAS. S. HOWE,
Chairman.

REPORT OF R. O. T. C. COMMITTEE.

The committee reports only as to progress, without specific recommendation on any matters involving action.

The chief effort of the committee during the year has been directed toward finding a basis for coöperative work between civilian professors and the military officer-instructors. It cannot be said that much progress has been made, but there is still hope for results. At many of the technical colleges where there are engineer units of the R. O. T. C., the second year of the officer training schedule is just being completed. Two years more will be required to bring the military program into full swing, and in that time the schools will have the problem more vividly before them.

One hopeful aspect is the apparent plan of the Chief of Engineers to permit the engineer officer on duty at the school to act with considerable latitude in grouping his military engineering courses in conformity with the school schedule. This is important, since it enables an adaptable officer to make his class work supplement the work of the school and so afford a proper basis for giving the student credit toward graduation. It is desirable that credit be allowed in order to encourage students to take the officer training, but the work must be made effective if this is to be done.

Coöperation is possible on either of two bases. First, on the basis of following credit in both directions, with no considerable adaptation of courses by either party to the needs of the other. Second, on the basis of civilian instructors teaching combined courses, prepared especially to fit the needs of R. O. T. C. students. This would mean introducing into certain standard engineering courses problems of military interest. It will be possible in its best form in cases where the instructor has seen service in the Corps of Engineers and is

interested in presenting the military viewpoint. It is assumed that the duties of the military instructors are such that they could not undertake to extend their teaching beyond military limits, so that this form of coöperation is mainly one-sided, from necessity. In such subjects as military law and history, civilian instructors may be secured to teach on the basis of the courses being of purely military interest, but this is a matter of personal, rather than school, coöperation.

The first interest of all consists in arriving at the condition indicated as the first basis for coöperation. Credit must needs be allowed both ways. The senior and junior work of the R. O. T. C. calls for the equivalent of five hours per semester. For men in the Engineer units it has been found feasible by the military officials to credit two hours for the regular technical school courses. It would seem that the school should do at least as much, which would leave to the student the carrying of one hour of extra uncredited work. This is not burdensome to the student, and it is not out of place for him to do some extra work in consideration of the fact that he is receiving a financial reward.

In schools requiring two years of military drill of all men students, the crediting for the sophomore and freshman R. O. T. C. work is easy. In schools where the whole four years of military work are optional, there is more difficulty in adjustment. The chairman of the committee represents the latter type of school, and the decision reached in that institution is to allow a total credit for the four years of thirteen (13) hours plus the gymnasium requirement of the freshman year. Ten of these hours are supposed to be for the modern language or other non-technical options.

The committee offers these credit suggestions as a basis of coöperation on the first basis. More time must be taken before definite suggestions can be made on the more extended plan.

P. F. WALKER,
Chairman.

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